SITE SAFETY PLAN
APPENDICES J - L

PRE-DESIGN SITE INVESTIGATION
AMERICAN CHEMICAL SERVICE, INC.

GRIFFITH, INDIANA

AUGUST 1995

PREPARED FOR:

ACS RD/RA EXECUTIVE COMMITTEE

GRIFFITH, INDIANA

• • •

PREPARED BY:

MONTGOMERY WATSON

ADDISON, ILLINOIS

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AMERICAN CHEMICAL SERVICE SITE SAFETY PLAN

american Chemical Service, Inc.
TECHNICAL PRODUCTS

P.O. Box 190 • Griffith, Indiana 46319
(219) 924-4359

Date: May 10, 1995

To: All Contractors and Unescorted Inspectors
From: ACS Management

Topic: Safety and Health Plan, Non-ACS Personnel

American Chemical Service Inc. (ACS) is providing the attached document titled "Safety and Health Plan, Non-ACS Personnel" for your review. ACS requires that "unescorted" Non-ACS Personnel who are working, inspecting, observing or auditing within the ACS facility read and understand the attached plan prior to entering the facility. Unescorted means Non-ACS Personnel who are not escorted by an ACS management employee.

Please address any questions regarding the information contained in this plan to ACS management.

a:\MEMO.510

american Chemical Service, Inc.
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Safety and Health Plan

Non-ACS Personnel

April 1995

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1.0 Introduction

This section to American Chemical Service's (ACS's) Site Safety and Health Plan titled "Non-ACS Personnel" has been prepared for the safety and health of visitors, Inspectors, and contractors entering the ACS facility. Pertinent information concerning plant safety and health rules, entry procedures, and the hazards present at the ACS facility is provided. Because ACS is a chemical manufacturer it must adhere to stringent safety and health regulations and requires all Non-ACS Personnel visiting the site to comply with plant Safety and Health rules established by ACS.

ACS recognizes four different categories of Non-ACS Personnel who may regularly visit/work at the site which include:

1.) **Visitors:** Site visitors who have a limited need to enter the plant manufacturing area on an infrequent basis.

2.) **Inspectors:** Personnel who have the need to enter specific areas for short or extended periods of time for the purpose of inspecting, observing or auditing.

3.) **Contractors:** Personnel who are contracted by ACS or others to conduct work within the ACS facility.

4.) **Transporters:** Personnel driving transportation vehicles for the sole purpose of delivering or shipping material to/from the site.

Specific safety and health rules and requirements have been established by ACS for each of the categories listed above based on the plant areas to be visited/worked in and the potential hazards present.

All Non-ACS Personnel, excluding transporters, are required to sign in at the ACS Facility office and obtain a badge as outlined in Section 3.0 of this document to provide accountability of personnel in the event of an emergency incident. All personnel entering the facility are required to comply with the general plant safety and health rules presented in Section 4.0.

Non-ACS Personnel allowed to work at the site unescorted (not in the presence of an ACS Management employee) must first receive a sufficient description and tour of the area to be worked in as discussed in Section 4.0. Unescorted Non-ACS Personnel are prohibited from entering areas they are not familiar with due to the potential hazards present at the site.

An explanation of ACS's Hazard Communication Program is provided in Section 6.0 for review by Non-ACS Personnel who will be working within the plant site. Section 7.0 describes ACS's Emergency Notification System that must be read and reviewed by all Non-ACS Personnel who work within the plant unescorted. All questions concerning this program can be addressed to ACS management personnel as discussed in Section 8.0

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2.0 Background of ACS Facilities

American Chemical Service, Inc. is a chemical manufacturer which normally operates twenty-four hours a day five days a week. The main products manufactured at this facility are plasticizers, oil additives, and gasoline additives. These products are manufactured through various manufacturing processes including chemical reactions, blending, and mixing operations.

ACS currently employs a sufficient number of personnel to effectively operate and manage this facility. ACS's employees are provided safety and training education on a monthly basis which covers the various topics which are required by the Indiana Occupational Safety and Health Administration (IOSHA) as well as additional topics which may be required by ACS's internal manufacturing department.

The property that ACS is situated upon is classified as a Superfund Site. This site is currently being studied and remediated under the direction of the U.S. Environmental Protection Agency, the Indiana Department of Environmental Management, and a steering committee comprised of the potentially responsible parties.

At this time no additional personal protective equipment is required to enter this site other than the personal protective equipment that is required in Section 5.0 of this program. Non-ACS Personnel will be notified in the event that any special precautions or additional personal protective equipment would be required to be worn in the plant manufacturing areas.

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3.0 Site Entry and Accountability

In order to provide for an accountability system of Non-ACS Personnel on-site in the event of an emergency situation, a Site Entry and Accountability system has been created and implemented at ACS. All Non-ACS Personnel as defined in Section 1.0 , excluding transporters, are required to sign in at the ACS Facility Office and obtain a badge. The badge shall be worn in a visible manner. If there is a need to be within the plant outside the normal day time working hours, 8:00 am to 4:30 pm, special arrangements must be made with ACS management. The following is a brief description of entry requirements for visitors, Inspectors, contractors, and transporters as defined in Section 1.0

3.1 Visitors

Each visitor shall sign-in at the ACS facility office using form SH 3.1 and obtain a badge if planning to enter any plant area(s). All visitors will be escorted within the facility. An ACS Management employee will be accountable for each visitor directly under his/her responsibility. In the event of an emergency situation the visitor will be directed in the proper actions to take.

3.2 Inspectors

Depending on the specific task (inspecting, observing or auditing) and the duration required in plant areas, Inspectors will be either escorted or unescorted. Entry procedures for each type of Inspector are stated below.

3.2.1 Escorted Inspectors

Each escorted Inspector shall sign-in at the ACS facility office using form SH 3.1 and obtain a badge if planning to enter any plant area(s). An ACS Management employee will be accountable for each escorted Inspector directly under his/her responsibility. In the event of an emergency situation the escorted Inspector will be directed in the proper actions to take. An escorted inspector must restrict his/her presence to designated plant areas. In particular, escorted inspectors visiting for purposes of the EPA Remedial Design/Remedial Action (RD/RA) may not enter plant manufacturing areas except as necessary to access RD/RA areas.

3.2.2 Unescorted Inspectors

All unescorted Inspectors shall be familiar with and comply with all general and contractor rules as stated in this document. Each unescorted Inspector shall sign in each day using Form SH 3.2 and secure an unescorted Inspector badge. This unescorted Inspector badge must be displayed at all times while within the facility boundaries. An unescorted inspector must restrict his/her presence to designated plant areas. In particular, unescorted inspectors visiting the ACS facility for the purposes of the RD/RA may not enter plant manufacturing areas except as necessary to access RD/RA locations. Whenever an unescorted Inspector will be leaving the facility he/she must sign out and return the ID badge to the sign-out location.

3.3 Contractors

Each contractor and employee of a contractor shall sign in each day using Form SH 3.2 and secure a contractor badge. This contractor badge must be visibly displayed at all times while within the facility boundaries. Whenever a contractor employee will be leaving the facility he/she must sign out and return the ID badge to the sign-out location.

All contractors must ensure compliance by their employees with this program. Failure to comply with this program could result in personal injury and/or illness in the event of an emergency incident.

For large scale and/or long term on-site operations conducted by a contractor, ACS may require that the contractor maintain an independent site entry and accountability system for the contractor's employees and subcontractors. The contractor's system shall meet the requirements of ACS's program and be approved by ACS management.

All RD/RA contractors and their employees must limit their presence to RD/RA areas except as necessary to access RD/RA work areas. No entry is allowed in plant manufacturing areas. Entry and exit routes shall be restricted as indicated on an ACS site map which may be changed from time to time.

3.4 Transporters

Each transporter entering the facility must report to either ACS or a contractor. The transporter will be directly under the control of either ACS or a contractor. Each transporter shall comply with current Department of Transportation Regulations.

3.4.1 ACS Contracted Transporters

All ACS contracted transporters must report to the ACS Production Office to receive directions on what procedures are to be followed and what area to report to for product loading and/or off-loading. The ACS Management employee responsible for the receipt of the transporter will inform the transporter of any and all potential hazards in the specific areas they will be in as well as the specific PPE that is required in the plant and in the loading/unloading area.

3.4.2 Non-ACS Contracted Transporters

All Non-ACS contracted transporters must report to the contractors facility located on site. The contractor shall be accountable for all transporters brought on site under the contractors orders, direction, subcontracting, etc.

The contractor who contracted the transporter shall be responsible for informing the transporter of any and all potential hazards present in the area(s) the transporter will be in as well as informing the transporter of the safety and health rules for the Non-ACS Personnel on site as stated in this document.

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AMERICAN CHEMICAL SERVICE
SITE SAFETY & HEALTH PLAN
NON-ACS PERSONNEL

Form	: SH 3.1
Section	: SH 3.0
Rev. No.	: 000
Date	: 4/20/95
Page No.	: 1 of 1

VISITOR SIGN-IN LOG

DATE	NAME	REPRESENTING	TIME IN	TIME OUT	BADGE #

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AMERICAN CHEMICAL SERVICE
SITE SAFETY & HEALTH PLAN
NON-ACS PERSONNEL

Form	: SH 3.2
Section	: SH 3.0
Rev. No.	: 000
Date	: 4/20/95
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CONTRACTOR & UNESCORTED INSPECTOR ACCOUNTABILITY LOG

I have read, understand and agree to comply with the Contractor Responsibilities as listed in the ACS Site Safety and Health Plan

DATE	NAME	REPRESENTING	TIME IN	TIME OUT	BADGE #

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4.0 Description and Tour of Work Areas.

This section applies specifically to Unescorted Inspectors and Contractors.
The on-site coordinator/supervisor for the contractor and/or Inspector will receive a sufficient description of the operations, personnel, and the potential physical and chemical health hazards of the department(s) they will be performing the work in. This representative of the contractor and/or Inspector will also be given a tour of the department(s) that they will be working in. The contractor and/or Inspector must not enter that area until this briefing and tour has occurred. This information will be provided by the ACS Management.

The on-site coordinator/supervisor for the contractor must then review the information concerning the department(s) they will be working in with their employees and/or subcontractors.

For the safety and health of all parties involved, the contractor, Inspector, and/or their employees shall not enter any area of the ACS facility that they are not familiar with or have not been authorized to be in from ACS management.

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5.0 Plant Safety and Health Rules

The following rules are the basic safety and health rules required of all Non-ACS Personnel while inside this facility. For specific situations additional requirements as specified by IOSHA may be required.

5.1 General Plant Rules

Smoking

Due to ACS storing a large quantity of combustible liquids on-site, ***NO*** individual is allowed to smoke at any location within the fenced area at any time.

Hot Work Permit

Any time that a contractor will perform "Hot Work" within this facility the contractor's supervisor must first notify ACS management so that the appropriate air monitoring, area inspection, etc., can be performed prior to the initiation of the hot work. An ACS Hot Work Permit will also be issued by ACS management. The contractor supervisor will receive a description of the hot work permitting process and rules and will be expected to comply with all ACS rules concerning hot work during the use of this permit.

Personal Protective Equipment

The minimum acceptable personal protective equipment that must be worn on site by all individuals entering the manufacturing portion of this facility consists of a hard hat, industrial safety glasses or chemical splash goggles, and steel toe - steel shank safety shoes. All PPE must be in compliance with current IOSHA, ANSI, and any other applicable standards.

Material Safety Data Sheets

All Non-ACS Personnel who bring hazardous substances on site shall immediately provide a clearly legible copy of the most recent MSDS for each substance brought on the ACS site to the ACS management. ACS management shall also be informed of the location(s) where this substance(s) will be located and the method of storage and distribution of said substance.

Material Safety Data Sheets, (MSDS), for all hazardous substances stored on site by ACS will be available for review by all Non-ACS Personnel performing operations on site upon their request.

Food and Beverage Consumption

Any food or beverage which is consumed on site shall be stored and consumed in an approved - non contaminated - area such as the front office, supervisors office, employee break room or other facility as provided by the contractor.

5.2.1 Visitors

All visitors of the ACS facility must comply with all of the general safety and health rules listed herein this document. Dependent upon the manufacturing areas to be visited, additional safety and health measurements may be required prior to the visitor entering a specific area. If this situation arises, the ACS Management employee escorting the visitor will address these issues as they arise.

5.2.2 Inspectors

5.2.2.1 Escorted Inspectors

All escorted Inspectors must comply with all of the general safety and health rules listed in this document. Dependent upon the manufacturing areas to be inspected, additional safety and health measurements may be required prior to the inspector entering a specific area. If this situation arises, the ACS Management employee escorting the inspector will address these issues as they arise.

5.2.2.2 Unescorted Inspectors

From time to time it may become necessary for an Inspector to be on site for an extended period of time for the purpose of observing an on-going operation, performance of an audit, etc. ACS Management shall make the determination when the Inspector will be allowed to be present in a specific area(s) of the facility, unescorted. All unescorted inspectors shall comply with the general safety and health rules as stated in this document in addition to all of the safety and health rules for contractors as stated in this document.

5.2.3 Contractors

All contractors entering the ACS facility shall comply with all general safety and health rules and contractor rules as stated in this document.

Contractor Facilities

ACS is designed and constructed to be self-supportive for its manufacturing facilities and employees only. ACS is not prepared to provide any office space, restroom or comfort facilities, food preparation, food consumption or any other type of facilities for contractors. Therefore, all contractors must provide their own facilities while on the ACS site. Any facilities brought onto the ACS site for use by contractors shall first be approved by ACS Management. The location and type of these facilities shall also be approved by ACS Management.

Permit Required Confined Space Program

All contractors performing on-site confined space entry procedures must comply with all applicable IOSHA regulations. All contractors must furnish their own equipment for performing these operations. ACS Management shall be notified prior to the start of such procedures in order that the confined space operations can be reviewed for possible hazards unknown to the contractor.

Unsafe Operations

If at any time a contractor will perform a task which poses or has the potential to pose a safety or health risk to ACS, its Management, employees, equipment, or processes or to other Non-ACS Personnel on site, that contractor shall immediately inform the ACS Management of such operation(s) prior to the commencement of such operation(s).

If a contractor is performing a task in a safe and healthful manner and an unsafe or unhealthful situation arises or is discovered, the contractor shall immediately stop the operation(s) and simultaneously notify the ACS Management of the situation.

Proof of Insurance, Permits, and Records

Each contractor must have submitted, to ACS Management, proof of current liability insurance, workmans comp insurance, and any other applicable insurance, permits, records etc., prior to commencing any operations on site. Proof of applicable levels of training and education for the tasks being performed on site shall be made available, upon request, to ACS Management by all Inspectors, and Contractors.

Acknowledgement of Review and Understanding of this Document

Each unescorted inspector and contractor must read and review this program, on an annual basis prior to conducting any work at the ACS facility.

Outside Contractor Illness and Injury Log

Due to the nature of the operations at ACS and the current requirements of the Indiana Occupational Safety and Health Administration Standard 29 CFR 1910.119 paragraph (h)(2)(vi) ACS must maintain a contractor's employee injury and illness log related to the contractor's work in process areas. Contractors are required to report any illness or injury occurring on-site to ACS management.

5.2.4 Transporters

Each transporter must have submitted, to ACS Management, proof of current liability and workmans compensation insurance. All Transporters who transport materials into or out of the ACS facility must comply with all of the general safety and health rules of this program as stated in this document. All transporters must also comply with current Federal Department of Transportation Regulations.

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6.0 ACS Hazard Communication Program

ACS, in compliance with the Indiana Occupational Safety and Health Standard 29 CFR 1910.1200 Hazard Communication and the Uniform Fire Code of Indiana, utilizes the following systems to identify hazards within portable containers, storage tanks and buildings on site.

Hazardous Materials Information System (HMIS)

The HMIS system is a color coded, numerical coded, and symbol coded system that is utilized on all portable containers of materials on site. The coding is as follows:

Blue area provides health information
1 - normal hazard
2 - slightly hazardous
3 - extremely hazardous
4 - deadly

Red area provides flammability information
0 - substance will not burn
1 - flashpoint above 200 degrees F.
2 - flashpoint between 100 - 200 degrees F.
3 - flashpoint below 100 degrees F.
4 - flashpoint below 73 degrees F.

Yellow area provides reactivity information
0 - stable
1 - unstable if heated
2 - violent chemical change
3 - shock and heat may detonate
4 - may detonate

White area at the top contains the name of the substance the way it appears on the MSDS. The white area at the bottom of the label contains the target organs is codes as follows:

A. Skin B. Eyes C. Liver D. Kidneys
E. Teeth F. Central Nervous System G. Respiratory System
H. Cardiovascular System I. Lungs
J. Blood or Hematopoietic System K. Immune System (Allergic Reaction)
L. Reproductive toxin

PPE section contains an alphabetically coded system to identify the personal protective equipment required to be worn when working with this substance under normal operations. The key to this code is included below.

PPE Key Code

A - Hard Hat and Safety Glasses.

B - Hard Hat, Safety glasses and compatible gloves.

C - Hard Hat, Safety glasses, compatible gloves, and splash apron.

D - Hard Hat, Safety glasses, compatible gloves, face shield and splash apron.

E - Hard hat, safety glasses, compatible gloves and a dust/mist respiratory mask.

F - Hard hat, safety glasses, compatible gloves, dust/mist respiratory mask, and a splash apron.

G - Hard hat, safety glasses, compatible gloves, and a vapor respirator.

H - Hard hat, safety glasses, compatible gloves, vapor respirator and a splash apron.

I - Hard hat, safety glasses, compatible gloves, and a dust/vapor respirator.

J - Hard hat, safety glasses, compatible gloves, dust/vapor respirator, and a splash apron.

K - Hard hat, safety glasses, compatible gloves, Full body chemical resistant coverall, supplied air respiratory protection and chemical resistant boots.

X - See your supervisor

*NOTE: Minimum acceptable personal protective equipment for on-site workers includes safety glasses with side shields, steel-toe safety shoes and a hard hat.

NFPA 704 Marking System

ACS, in compliance with the Uniform Fire Code of Indiana, utilizes the NFPA 704 marking system on the storage tanks and buildings on site to identify health, fire, or reactivity hazards of a 2 or above within that tank and building. These signs are placed on the most common route of approach to that building and/or tank. The NFPA 704 sign is defined as follows:

Blue area provides health information
1 - normal hazard
2 - slightly hazardous
3 - extremely hazardous
4 - deadly

Red area provides flammability information
0 - substance will not burn
1 - flashpoint above 200 degrees F.
2 - flashpoint between 100 - 200 degrees F.
3 - flashpoint below 100 degrees F.
4 - flashpoint below 73 degrees F.

Yellow area provides reactivity information
0 - stable
1 - unstable if heated
2 - violent chemical change
3 - shock and heat may detonate
4 - may detonate

White area provides additional information concerning additional hazards of the materials such as:
ACID - acidic
ALK - Alkalinic
COR - corrosive
OXY - oxidizer
W - water reactive

Material Safety Data Sheets

All Non-ACS Personnel who bring hazardous substances on site shall immediately provide a clearly legible copy of the most recent MSDS for each substance brought on the ACS site to the ACS management. ACS management shall also be informed of the location (s) where this substance(s) will be located and the method of storage and distribution of said substance.

Material Safety Data Sheets, (MSDS), for all hazardous substances stored on site by ACS will be available for review by all outside contractors performing operations on site upon their request.

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7.0 Emergency Notification System

DIAL 71

The ACS plant facility has an on site alarm system which consists of four strategically placed sirens throughout the plant. This siren system can be activated by lifting the receiver on any in-plant phone and dialing the numbers "71" waiting for the ringing in the receiver and then hanging up the receiver. The four sirens will then be activated throughout the plant until they are shut off by the emergency coordinator or his alternate. At the phone location, in close proximity to the phone, is a toggle switch on an explosion proof box. By placing this switch in the up position a revolving yellow light will be activated on that building to allow the employees and emergency response team to know what area the emergency has occurred in.

Contractors & Unescorted Inspectors Responsibilities

Each contractor and unescorted Inspector has the responsibility to become thoroughly familiar with the area that they are working in. This includes the locations of the in-plant phone, emergency escape routes, location of the nearest eye wash, fire extinguishers, and emergency exits.

In the event that a contractor or unescorted Inspector causes an emergency situation, the following procedures must be followed:

1. Immediately stop all operations.

2. Evacuate all unnecessary employees from the affected area to an upwind and uphill location. This includes leaving all equipment and vehicles in the area of the incident and relocating all employees from the affected area.

3. Immediately activate the emergency notification system by dialing "71" on the nearest in-plant phone.

4. If the incident can be mitigated safely by the contractor then such action should be taken. If the incident is of a very minor nature then the contractor may simply notify the ACS Management verbally. Each incident will be different and will be of varying nature. When in doubt if the emergency notification system should be activated the contractor shall activate the system immediately.

5. The supervisor for the crew that created the incident will provide as much information as is possible to the Emergency Coordinator or his alternate concerning the events occurring which lead up to the incident, personnel head count, etc.

6. The contractor(s) and their employees will cooperate fully in any and all investigations concerning any and all incidents occurring at this facility.

Activation of Emergency Notification System

In the event that the emergency notification system is activated while the contractor and/or unescorted Inspector is inside the facility the following actions must be taken:

1. Immediately stop all operations.

2. Evacuate all unnecessary employees from the affected area to an upwind and uphill location. This may be to a location outside of the plant. The wind direction can be determined from a wind sock located on the east side of the site.

3. If off site relocation is required, the predetermined meeting places are as follows:
   a. If the personnel are required to leave the facility going south - the meeting place is the intersection of Colfax and Reeder Roads.
   b. If the personnel are required to leave the facility going north - the meeting place is at the Grand Trunk Rail Road Tracks.

4. The supervisor responsible for each of the contractor and/or inspection companies and/or agencies on site is responsible for taking a head count of their employees and reporting this information to the proper ACS representative.

5. The Non-ACS Personnel will remain off site until authorized to return by the ACS Facility coordinator or his alternate.

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8.0 Point of Contact for Questions and Answers

All questions concerning this program or this facility must be directed to the ACS Management Staff. This process is implemented to alleviate duplication of effort as well as to minimize confusion.

ACS Management

All ACS supervisory personnel are designated with a blue hard hat. These individuals are authorized to interact with Non-ACS Personnel on a very limited scale, i.e. questions concerning the specific department the Non-ACS Personnel are working in. These individuals are the main members of the on-site emergency response team and will take an aggressive and offensive role during all emergency incidents occurring at this facility.

ACS Production Employees

All ACS production employees are designated with a white hard hat. These individuals are not authorized to provide information or answer questions of Non-ACS Personnel. These individuals are a part of the on site emergency response team and will fulfill a proactive support role to the supervisory personnel during all emergencies occurring on site.

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Air Monitoring Equipment Manuals

INSTRUCTION MANUAL

OVM / DATALOGGER

MODEL 580B

Thermo Environmental Instruments, Inc. MODEL 580B

CLASSIFIED BY
UNDERWRITERS LABORATORIES, INC.®
AS TO ELECTRICAL SHOCK AND EXPLOSION HAZARD ONLY FOR USE IN
CLASS 1, DIVISION 2, GROUPS A, B, C & D
HAZARDOUS LOCATIONS
70X0

THERMO ENVIRONMENTAL INSTRUMENTS INC.

8 WEST FORGE PARKWAY . FRANKLIN, MA 02038

TEL: (508) 520-0430 . TELEX: 200205 THEMO UR

FAX: (508) 520-1460

P/N 16860

REVISED 9/91

INSTRUMENT WARRANTY

WARRANTY. Subject to the exceptions stated below, Thermo Environmental Instruments Inc. agrees to correct, either by repair or at our opinion, by replacement, any defects in materials or workmanship which develop within one year from the date of surface shipment, parts and labor supplied free of charge and surface transportation costs to be borne by the offeror both ways, provided that the investigation and inspection defects developed under normal and proper use.

The exceptions mentioned above are: (1) All items claimed must be returned to Thermo Environmental Instruments Inc., transportation charges collect, and will be shipped prepaid and charged to the customer unless the item is found to be defective and covered by the warranty in which case Thermo Environmental Instruments Inc. will pay all transportation charges; (2) Thermo Environmental Instruments Inc. agrees to extend to the customer whatever warranty is given to Thermo Environmental Instruments Inc. and incorporated into products sold to the customer; (3) Thermo Environmental Instruments Inc. shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own authorized service personnel, or service personnel from an authorized representative, unless such repair is minor, merely the installation of a new plug-in component; (4) If any model or sample was shown to the Purchaser, such model or sample was shown merely to illustrate the article and not to represent that any article delivered hereunder would conform to the model or sample; and (5) Spare parts are warranted for ninety (90) days.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, IMPLIED OR STATUTORY. SELLER DOES NOT WARRANT MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, OR MAKE ANY OTHER WARRANTY OR AGREEMENT EXPRESSED OR IMPLIED WITH RESPECT TO ANY ARTICLES COVERED HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THOSE EXPRESSLY STATED IN THIS CONTRACT.

580B USER MANUAL
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SECTION I

INTRODUCTION

1 INTRODUCTION

The 580B is a portable Organic Vapor Meter (OVM), which detects and quantitates most organic vapors with a highly sensitive photoionization detector (PID). The 580B has an operating range of 0-2000 parts per million (ppm) with a minimum detectable of 0.1 ppm. No support gases are required.

The 580B is controlled by a microprocessor which provides many features that were not previously available. Maximum signal hold, detector linearization, overrange lockout, IBM PC (or compatible) interface, extensive data logging capabilities and much more. With the many features provided by the 580B leak detection, head space measurements, and field survey are all easily accomplished. Completely portable, the 580B operates from internal batteries for eight hours in the field.

1.1 ABOUT THIS MANUAL

This manual is broken down into eight chapters. The first chapter (this one) provides a general overview of the 580B. Chapter two discusses, in great detail, the extensive facilities of the 580B. The focus of this chapter is on how to use the seven switches to access the various facilities. Chapter three explains, in detail, how to perform routine maintenance on the 580B. Chapter four is a technical discussion of calibration and methods for generating standards. Chapter five is a technical discussion of a few applications which illustrate some of the uses of the 580B. Chapter six is a technical discussion of methods for collecting a sample using the 580B. Chapter seven is a discussion of the communication facilities provided by the 580B. Chapter eight contains two flow charts which illustrate the 580B software flow. This chapter is a helpful tool for the new user. Appendix A is a detailed explanation of the 580B communication protocol. This chapter is provided in order to allow a programmer to develop specialized communication software for the 580B. There are several other addendums which contain miscellaneous information about the 580B.

1.2 INSTRUMENT OVERVIEW

This section describes various points of interest on the 580B. Each number refers to a number in Figure 1.1.

1. **POWER PLUG** - The power plug is used to run the instrument from its internal batteries. There is a chain attached to the power plug so that it will not be lost.

2. **RS-232 CONNECTOR** - This connector is used for communi-

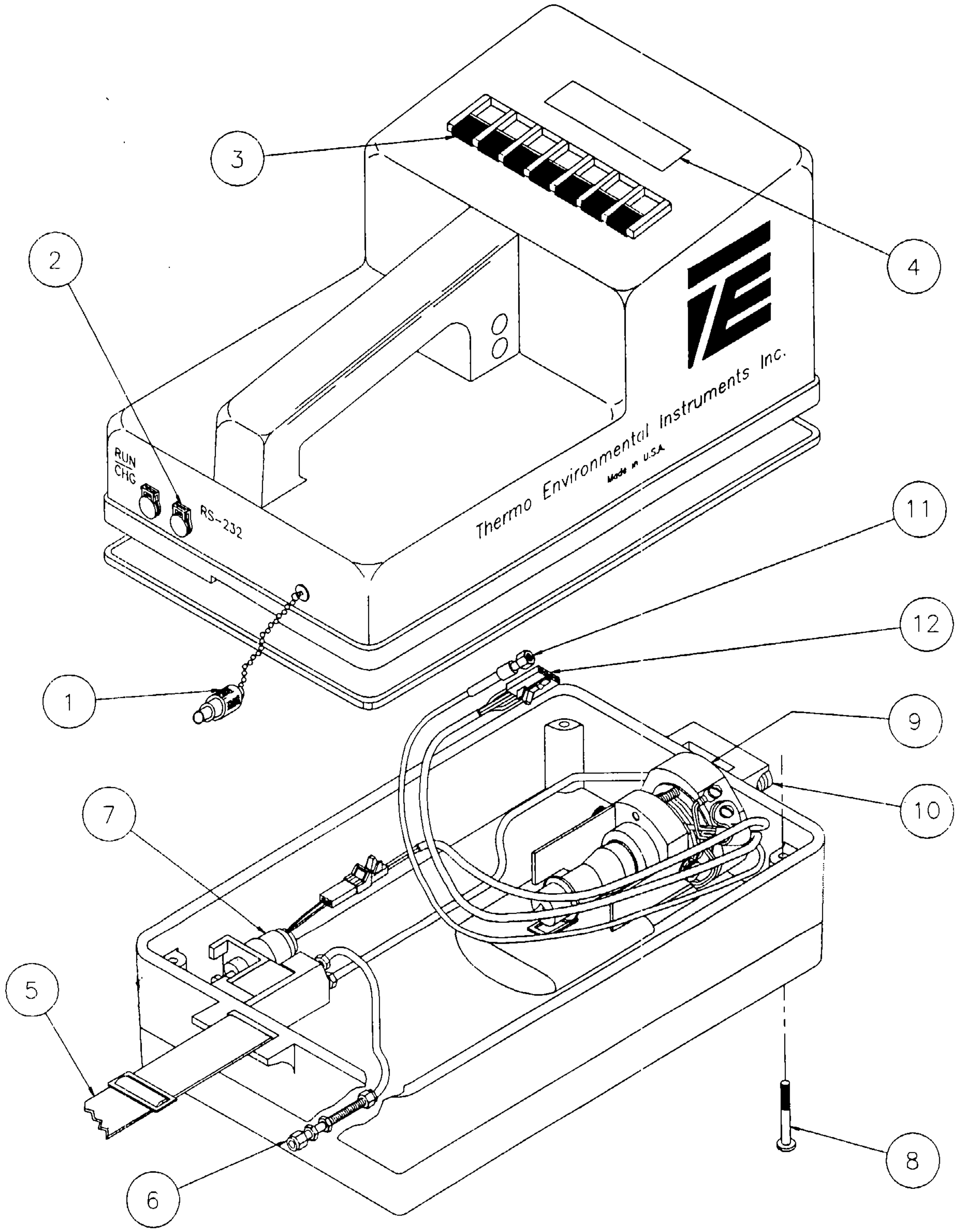


Figure 1.1
Instrument Assembly

cation with a serial printer or computer. A communication cable provided with the instrument fits into the receptacle.

3. **KEY PAD** - There are seven switches which operate the 580B. The switch marked ON/OFF is used to turn the pump and lamp on and off. The switch marked LIGHT will turn on backlighting for the two line display. The other five switches perform various functions. For a detailed description of the function of each switch see chapter two or the flow charts in chapter eight.

4. **DISPLAY** - The 580B has a two line by sixteen character display.

5. **SHOULDER STRAP** - There is an adjustable shoulder strap for carrying the 580B.

6. **SAMPLE EXIT PORT** - The 580B sample is drawn into the detector by a positive displacement pump and then sent back out through the exit port.

NOTE : The photoionization detector is a non destructive detector so the sample may be collected at the exit for further analysis (see Chapter Six).

7. **PUMP** - The 580B pump draws the sample into the detector.

8. **MOUNTING SCREWS** - There are four captive screws which hold the 580B top and bottom together. The screws are specially designed so that they do not fall out when they are loosened out of the case top.

9. **DETECTOR** - The photoionization detector is shown with the lamp and high voltage power supply.

10. **SAMPLE INLET** - Sample is drawn into the detector through the sample inlet at the front of the 580B.

11. **SIGNAL CABLE** - The PID signal is brought up to the microprocessor, for analysis, via the coaxial signal cable.

12. **BASE HARNESS** - The base harness plugs into a connector on the case top.

1.3 580B FEATURES

This section provides a brief overview of the various features of the 580B. After reading this section the user should have a good idea of what the instrument can do. Chapters two and three will explain, in detail, how each feature is selected.

TURNING ON PUMP AND LAMP - The pump and lamp are turned on by pressing the ON/OFF switch (the instrument power must already be on).

CALIBRATION - Calibration of the 580B is extremely important. Chapter two explains how to calibrate the 580B in great detail. Chapter four discusses at length some of the basic theory and methods behind calibration. It is strongly suggested that this chapter be read in order to gain a deeper understanding of usage of the 580B. Chapter three also discusses calibration.

CONCENTRATIONS - Once the lamp and pump have been turned on the 580B begins to display the concentration of the incoming sample on the bottom line of the display. Normally the top line of the display will be a bar graph (logarithmic on a scale of zero to 2000). The operator may however select the MAX HOLD mode of operation. When in MAX HOLD, the top line of the display will show the highest concentration recorded.

LOGGING - The 580B provides extensive facilities for logging information. The operator may save a particular reading along with a six digit location code and a date and time stamp. If the 580B is in the MAX HOLD mode when logging is initiated then the max hold value will be logged.

AUTO LOGGING - Logging may be performed automatically by using the 580B's auto logging feature. Auto logging is not allowed while in the MAX HOLD mode. When auto logging is selected a LOGGING INTERVAL is selected (anywhere from one second to 99 minutes and 59 seconds). At the end of each logging interval the present concentration will be logged (the location code is automatically incremented each time).

AVERAGE - The 580B normally updates the concentration once per second. The operator has the option of setting the averaging time anywhere from one second up to four minutes.

NOTE : The bottom line of the display will be blank until the first averaging interval is completed. The top line will however be updated each second.

RESPONSE FACTOR - A response factor may be used in order to relate a particular gas to the calibration gas. When computing the displayed concentration the microprocessor multiplies the measured concentration by the response factor and displays the result. If the response factor is one, then the concentration is not changed. Chapters four and five explain some uses of the response factor.

LAMP SELECTION - The 580B allows for calibration data to be saved for one 10.0 eV lamp and one 11.8 eV lamp. This allows lamps to be switched in the field without requiring recalibration. A lamp serial number may also be entered.

ALARM - An alarm level may be selected. The 580B will sound an audible alarm (the top line will also indicate an alarm) whenever the concentration goes above the selected alarm level.

ACCESS - The 580B provides four access levels so that various features may be "locked out." User identification number and instrument number are also provided.

CLOCK - The 580B has an internal clock which will run even when the instrument power is cut off.

COMMUNICATION - The 580B has a serial communication port for outputing data to a serial printer. Many of the 580B features may be accessed from a remote computer through the serial communication port (there is communication software available which will run on an IBM PC or clone).

DISPLAY LOGGED DATA - The logged data may be displayed on the 580B's two line display.

SECTION II

PRINCIPAL OF OPERATION

2.1 PHOTOIONIZATION DETECTOR OPERATION & THEORY

2.1.1 GENERAL

The sample is drawn into the ion chamber by a pump down stream of the detector. Here the sample is bombarded by ultra-violet light (UV) exciting the molecule. If the energy, (hU) of the UV light is greater than the ionization potential (IP) of the sample molecule (R) an electron will be removed, ionizing the molecule. A positively charged molecule and a free electron are produced, as :

$$R + hu \rightarrow R^+ + e^-$$

Several typical reactions follow:

C_6H_6 (benzene) + hu -> $C_6H_6^+ + e^-$	IP = 9.2 eV
$H_2C{=}CHCl$ (VCM) + hu -> $H_2C{=}CHCl^+ + e^-$	IP = 9.9 eV
C_3H_8 (propane) + hu -> $C_3H_8^+ + e^-$	IP = 10.9 eV

For this reason the ionization potential of the subject molecule plays an important role in selecting the lamp energy. Ionization potentials are expressed in electron volts (eV). A list of ionization potentials can be found in Appendix E of this manual or a more complete list in the CRC "Handbook of Chemistry and Physics".

2.1.2 LAMP ENERGIES

There are three lamps available from TEI, 10.0 eV, 10.6 eV, and 11.8 eV. The different energies are obtained by filling the lamp envelopes with different gases and selecting a window which will pass the wavelength produced when the gas is excited. The combination of gas and windows which produce these energies are listed below:

ENERGY	GAS	WINDOW	WAVELENGTH (nm)
10.0 eV	Krypton	MgF	123.6
10.6 eV	Krypton	MgF	117.4
11.8 eV	Argon	LiF	105.1

Though ionization potential will help the user select a lamp, it will not give any information as to the performance of the detector in measuring a specific compound. The response of the system varies considerably from compound to compound even though they may have the same ionization potential. Some generalizations may help the user obtain a feeling for the difference in response between compounds.

2.1.3 COMPARATIVE RESPONSE

The following is an idealized response chart. No attempt is made to quantitate the relationship, it's a guideline.

Decreasing PID Response: Aromatic Compounds
Unsaturated Compounds
Saturated Compounds
Ketones
Alcohols
Compounds with Sub Groups

It becomes obvious that sensitivity is influenced by the electronegativity of the molecule though this is not a predictable measure of performance. The only true test of performance is to measure the specific compound of interest and compare it to a good performing standard such as isobutylene.

2.1.4 RESPONSE FACTORS

This relative comparison with isobutylene mentioned above is a very effective way of measuring a variety of compounds without the need to recalibrate for each compound.

The development of a RESPONSE FACTOR allows the operator to correct the instrument's response given a one to one correspondence for all compounds measured, using isobutylene as the reference standard.

Note: Because there is variation in lamp production and hence performance, it is suggested that all calibration and subsequent development of response factors be done on the same lamp/instrument combination.

The preparation of standards and the development of response factors is discussed in subsequent sections of this manual. Once the response factor is generated, it is entered into the 580. The instrument automatically reports the concentration of the compound measured in relative units. It is important to recognize that all compounds measured at that time will be reported relative to the response factor entered in the instrument. For example, if we have calibrated the instrument on isobutylene and have entered a response factor for benzene, we will read concentrations with a one to one correspondence to benzene. If during these measurements toluene or any other compound is encountered, the instrument will report the concentration as if it was measuring benzene. For this reason care should be taken when using this facility.

The above discussion should give the reader a good overview of PID performance. To further understand the intricacies of the

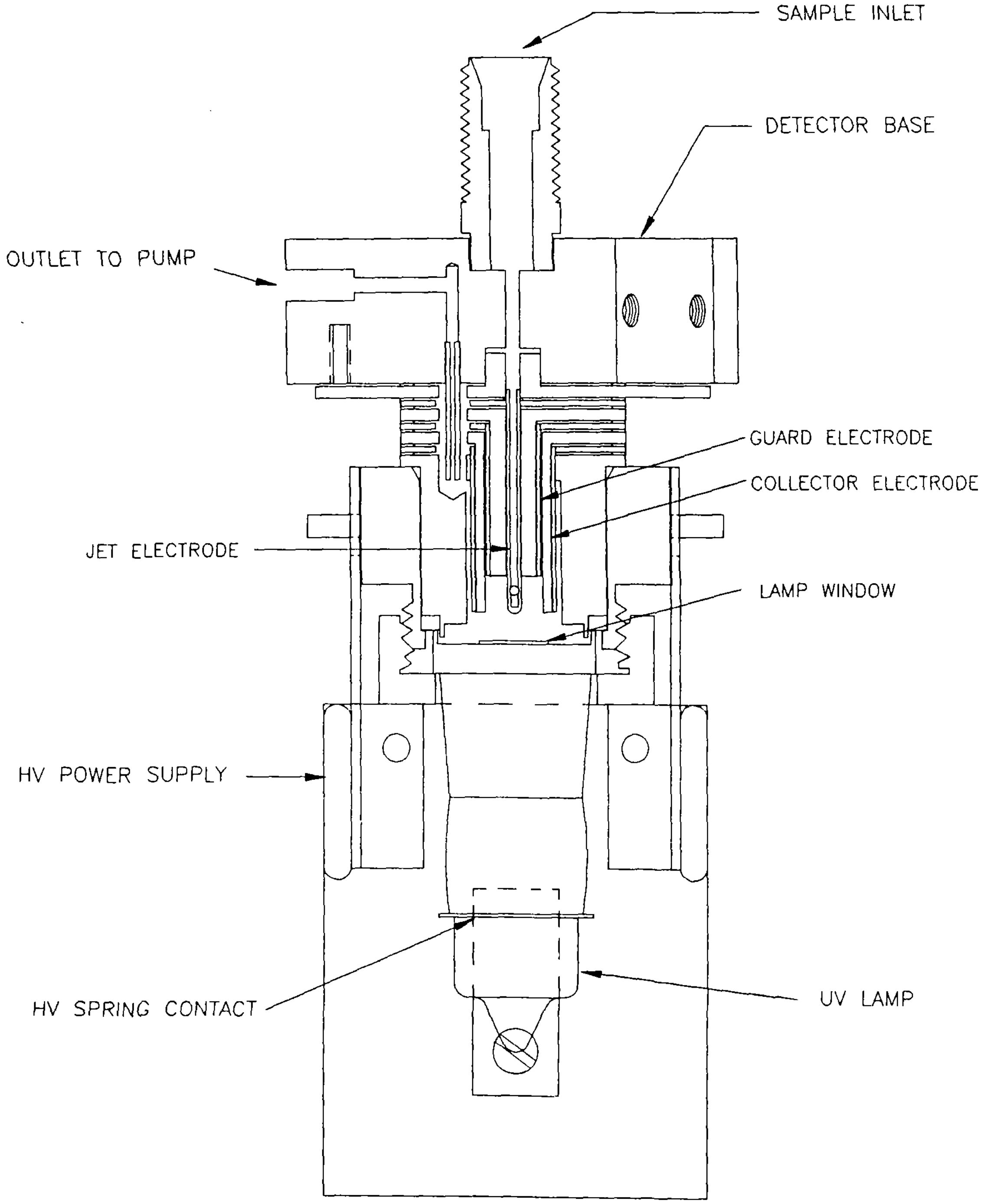


Figure 2.1
Photo Ionization Detector

instrument it is suggested that the user prepare a number of standards of different compounds and measure them relative to isobutylene. Included in this comparison should be several mixtures of compounds such as gasoline, paint thinner, or cleaning solvent, etc. Through this type of study the inequity of the PID response will be better understood making the Model 580 a more effective tool. The use of the instrument is discussed in greater detail in subsequent sections.

2.1.5 PHOTOIONIZATION DETECTOR

The detector is constructed of Teflon and stainless steel to eliminate chemical interaction with the surfaces that are encountered by the sample. To further reduce possible interaction with the surfaces, the flow rate thru the detector is high, 400 - 500 cc/min developing a very dynamic transport of the sample.

Referring to Figure 2.1, the sample is drawn into the ionization chamber through the jet electrode where the UV radiation from the lamp ionizes the sample. A bias voltage of several hundred volts is applied to the jet to aid in the collection of ions. As a result of the ionization process and the impingement of the UV energy from the lamp on the sample, positively charged ions and free electrons are produced. The jet is negative relative to the collector where the electrons are collected.

Between the jet and the collector, separated on both sides by Teflon, is the guard electrode. Its function is to eliminate surface currents which could flow between the two active electrodes. When the Teflon surfaces become dirty during use, there can be the development of a conduction path on the Teflon, which increases in high humidity situations. The guard electrode eliminates this path. The collector electrode is connected to the electrometer which measures the ion current produced during the ionization process. The sample is moved through the detector by an external pump which is on the exit of the detector.

2.2 PROGRAM OPERATION

2.2.1 INTRODUCTION

The 580B has seven switches located just below the display. They are labeled:

ON/OFF   MODE/STORE   RESET   LIGHT   +/INC   -/CRSR   SPKR

The ON/OFF switch toggles the lamp and pump power between on and off. The MODE/STORE, RESET, +/INC, -/CRSR and SPKR switches all have various meanings (including none at all) depending upon the mode. The SPKR switch normally is used to toggle the instrument speaker between on and off. Pressing the MODE/STORE switch will cause the 580B to return to the Run mode, except when the 580B is already in this mode. In which case it will cause the 580B to enter the Log mode.

The LIGHT switch is used to illuminate the display.

The 580B has several modes. Some of the modes may have sub modes. The modes and sub modes are tabulated below.

- Run mode
  - Concentration meter normal
  - Max hold
- Log mode
- Parameter mode
  - Calibration mode
- Access mode
- Clock mode
- Communication mode

The following sections will describe each mode and how to get to them and through them. It is strongly suggested that this section be carefully read and that the 580B be used along with the manual in order to re-enforce the manual.

2.2.2 POWER FOR LAMP AND PUMP

When the 580B is first turned on (see section 1.3) the display will indicate that the lamp is not lit. Pressing the ON/OFF switch will tell the microprocessor to turn on the lamp and the pump. The microprocessor will send power to the lamp and pump and then "look" to see if the lamp is actually lit. If it did not light then the microprocessor will try again.

If after fourteen seconds the lamp still will not light, then the microprocessor will indicate a lamp out condition.

In the event that the microprocessor is unable to light the lamp, check the seating of the lamp (see section 3.1). If the problem persists, call service.

Once the lamp is lit, the display will show the PPM (parts per million) on the bottom line. The top line will either be a bar graph or the maximum reading (see section 2.2.3).

To turn the lamp and pump off simply press the ON/OFF switch.

2.2.3 RUN MODES

The 580B has two run modes, Max Hold and Concentration meter. The run mode is selected in the Parameters section (see Section 2.4). In the concentration meter mode the top line of the display will be a bar graph. The bar graph is a logarithmic bar graph over the range of 0 to 2000 PPM. The bar graph is intended as a rough visual indication of the current PPM. The bottom line will indicate the exact PPM.

In the Max Hold mode the top line of the display will indicate the maximum reading. The bottom line of the display will indicate the current PPM. Whenever a new maximum is seen, the top line will be updated. The Max Hold reading may be reset by pressing the RESET switch while in the run mode.

2.2.4 LOG MODE

The ability to "log" data is one of the 580B's greatest features. Readings may be stored for later analysis. Each reading will have a date and time as well as a location code associated with it. Up to over 700 readings may be stored. Logged data may even be sent to a printer or computer via an RS-232 serial communication port (see section 2.7).

The Log mode is entered from the Run mode by pressing the MODE/STORE switch. When this switch is pressed from the Run mode the display will show:

LOG THIS VALUE?

on the top line and either PPM or MAX PPM on the bottom line depending upon which run mode the 580B is currently in. By pressing the +/INC switch the display will then show:

LOC. CODE 000001

on the top line (the actual location code may not be 000001). The location code may now be entered. By pressing the +/INC switch the number above the cursor may be incremented. By pressing the -/CRSR switch the cursor may be moved to the next digit. The 580B automatically increments the location code each time a data point is logged.

Once the desired location code has been entered, pressing the MODE/STORE switch will "log" the data point. This means that the reading displayed on the bottom line, along with the location code, the current date and the current time will be stored into the 580B's memory. The 580B will then return to the Run mode.

If for any reason logging is not desired, pressing the RESET switch rather than the MODE/STORE switch will cause the value not to be stored. The 580B will then go back to displaying:

LOG THIS VALUE?

Pressing the mode switch will now return the 580B to the Run mode.

It is possible, when attempting to log a data point, that rather than the display showing "LOC. CODE 000001" it will show "BAR CODE: ." Don't be alarmed. This has happened becouse the location mode selection is not properly set. Section 2.4.3 describes how to set this parameter. Pressing the mode/store switch will cancel the logging operation and return to the run mode. The location mode selection should be changed as described in section 2.4.3.

2.2.4A AUTO LOGGING MODE

The 580B may be instructed to automatically log data according to a predefined time interval. AUTO LOGGING is selected from within the Parameters section (see section 2.4). At the end of the logging interval (settable from 1 second up to 99 minutes and 59 seconds) the current average ppm value will be logged and the logging interval will be restarted.

NOTE: Auto logging is not allowed with the Max Hold mode.

2.2.5 SPEAKER

While the 580B is in the Run mode the speaker may be turned on. The speaker will generate a "clicking" which will increase in speed as the concentration increases. The purpose of the speaker is to give the operator an audible indication of the PPM. The speaker may be turned on or off by pressing the SPKR switch. The speaker rate may also be changed by changing the switches located inside of the instrument. Only one of the four speaker rate switches should be on (in the down position) at any time.

2.2.6 LOW BATTERY

The 580B will display a warning when the battery is low. The warning will be a flashing B in the left hand corner of the bottom line of the display when the 580B is in the Run mode. The 580B should be recharged when the low battery warning is activated.

2.2.7 OVERRANGE

The 580B will display an overrange warning if the concentration goes above 2000 PPM. The top line of the display will show:

OVERRANGE

Once an overrange condition occurs the instrument will "lock out". This means that the overrange warning will continue to be displayed until the instrument is brought to a "clean" area. A clean area is defined to be an area where the concentration of organic vapors is below 20 PPM. The 580B will continue to indicate PPM on the bottom line during an overrange condition.

2.2.8 ALARM

The 580B has an alarm which will sound if the PPM rises above the alarm setting. The alarm setting is entered in the Parameters mode (see section 2.4.3). If the speaker is not activated then the alarm will of course not be heard. Once the PPM drops below the alarm setting the alarm will turn off. The top line of the display will also indicate when there is an alarm condition.

2.3 MAIN MENU

By pressing the MODE/STORE switch from the Run mode and then pressing the -/CRSR switch when asked if logging is desired,

the 580B will display the main menu:

R/COMM -/PARAM
+/ACCESS S/CLOCK

The other four operating modes (Communication, Parameters, Access and Clock) may be entered from the Main menu. The operating mode may always be returned to by pressing the MODE/STORE switch.

2.4 PARAMETERS MODE

All of the 580B operating parameters are entered in the Parameters mode. The 580B is also calibrated from within the Parameters mode.

The Parameters mode may be entered by pressing the -/CRSR switch from the main menu.

There are nine different sections in the Parameters mode.

1. Run mode selection
2. Auto logging selection
3. Location mode selection
4. Average time selection
5. Alarm setting
6. Lamp selection
7. Response factor setting
8. Calibration
9. Free space indication

Pressing the +/INC switch will advance the 580B to the next section. Pressing the -/CRSR will advance the 580B to the previous section. Each section and any of its sub-sections will be described in the following pages. It is important to note that when the 580B is in a sub-section of any of the above sections that the +/INC and -/CRSR switches will have a different meaning. This may seem confusing at first but will become clear after stepping through each section.

2.4.1 RUN MODE SELECTION

There are two Run modes. Concentration meter normal and Max Hold (see Section 2.2.3). The top line of the display will show:

CONC. METER

the bottom line will show:

"RESET" TO CHG

the bottom line will alternate every two seconds with:

MAX HOLD

if the 580B is in the Max Hold mode. Pressing the RESET switch will cause the 580B to show:

MAX HOLD
+ = USE/ - = NO

if the +/INC switch is pressed then the Max Hold mode will be selected. If the -/CRSR switch is pressed then the Concentration meter normal mode will be selected. In either case the 580B will then return to the previous screen.

2.4.2 AUTO LOGGING SELECTION

The 580B can be configured to automatically log data points. The top line of the display will show:

AUTO LOGGING

The bottom line will alternate between "RESET TO CHG." and "ON" or "OFF". Pressing the RESET switch will cause the 580B to show:

AUTO LOGGING
+/ON -/OFF

Pressing the -/CRSR switch will turn auto logging off and return operation to the previous screen. Pressing the +/INC switch will enable auto logging and allow setting of the logging interval. The display will show:

INTERVAL 00:01
"RESET"WHEN DONE

The +/INC switch will increment the number above the cursor and the -/CRSR switch will move the cursor. The logging interval format is MM:SS (where M is minute and S is second). Pressing the RESET switch will return operation to the first auto logging screen.

2.4.3 LOCATION MODE SELECTION

The 580B may be configured to accept a six digit location code which is entered via the keypad. There is an alternate method for entering location codes however UL approval has not yet been obtained for this option. For updated information contact Thermo Environmental Instruments inc.

The display shows the currently selected location mode. For example the display will show:

Loc. code mode
"reset" to chg.

When the 580B is configured to enable operator editing of the location code, pressing the RESET switch causes the 580 to show:

Bar code mode
"reset" to chg.

The 580B is now configured for the alternate location mode (which is not presently available for use in hazardous locations). Pressing the reset switch will cause the 580B to be configured for location code mode.

2.4.4 AVERAGE TIME SELECTION

The 580B can be configured to display the average PPM from once a second up to once every four minutes. The display will show:

AVERAGE = 0:01
"RESET" TO CHG

Pressing the RESET switch will cause the 580B to show:

AVERAGE = 0:01
"RESET"WHEN DONE

The +/INC switch will increment the number above the cursor and the -/CRSR switch will move the cursor. The average time format is M:SS (where M is minutes and S is seconds).

NOTE: The maximum averaging interval is four minutes.

2.4.5 ALARM SETTING

The 580B will display the current alarm setting on the top line of the display. The setting may be changed by simultaneously pressing the RESET switch with either the +/INC switch to increment the digit above the cursor or the -/CRSR switch to move the cursor.

2.4.6 LAMP SELECTION

The 580B will display:

LAMP

on the top line. The bottom line will alternate every two seconds between:

"RESET" TO CHG

and the currently selected lamp setting and its associated serial number.
i.e.

11.8eV 000000

By pressing the RESET switch, the 580B will display:

+/10eV -/11eV

on the bottom line. Pressing the +/INC switch will select the 10.0 eV lamp. Pressing the -/CRSR switch will select the 11.8eV lamp. In either case the 580B will then allow editing of the lamp serial number. The display will show:

SERIAL # 000000
"RESET"WHEN DONE

The +/INC switch will increment the number above the cursor and the -/CRSR switch will move the cursor. Pressing the RESET switch will return operation to the original lamp screen.
When using a 10.0 eV lamp or a 10.6 eV setting should be selected. When using an 11.8 eV lamp the 11 eV setting should be selected.

2.4.7 RESPONSE FACTOR SETTING

The current Response Factor setting will be displayed on the top line of the display. The Response Factor may be changed by simultaneously pressing the RESET switch with either the +/INC switch to increment the digit above the cursor or the -/CRSR switch to move the cursor.

The response factor is used to equate the response of one organic vapor with that of the calibration gas. The current reading is always multiplied by the response factor in order to obtain the displayed concentration. A response factor of one will not change the displayed concentration.

2.4.8 CALIBRATION

The 580B will display:

"RESET" TO
CALIBRATE

The calibration mode may be entered by pressing the RESET switch.
The 580B will display:

RESTORE BACKUP
+ = YES

The previous calibration information may be restored by pressing the +/INC switch. The 580B will then return to the previous screen. If the backup is not desired, by pressing the -/INC switch the calibration routine will continue. The display will show:

ZERO GAS
RESET WHEN READY

Once zero gas has been introduced the RESET switch should be pressed. The 580B will then zero the instrument. The 580B will display:

MODEL 580B
ZEROING

Once the 580B has been zeroed the 580B will display:

SPAN PPM = 0000

The Span gas concentration may now be entered by simultaneously pressing the RESET switch and either the +/INC switch to increment the digit above the cursor or the -/CRSR switch to move the cursor. Once the span gas concentration has been entered the +/INC switch should be pressed.
The 580B will then display:

SPAN GAS
RESET WHEN READY

Once the span gas has been introduced the RESET switch should be pressed. The 580B will then calibrate the instrument. The 580B will display:

MODEL 580B
CALIBRATING

Once the 580B has been calibrated the 580B will go back to the beginning and display:

"RESET" TO
CALIBRATE

If during the zeroing or calibrating of the 580B a steady reading was not seen then the 580B will display:

CAL ERROR
RESET WHEN READY

Pressing the RESET switch will return the 580B to zeroing or calibrating (depending of course on which it came from).

See Section 4.1 for tips on calibrating the 580B.

2.4.9 FREE SPACE INDICATION

This section will give a rough indication of how much room is left for logging data points. The screen will display a bar graph on the top line and the amount of free space on the bottom line. The number indicates the total number of bytes which are available. Each data point takes fifteen bytes. Other bytes may also be needed in order to store other important information. This is why only a rough indication of room may be given.

2.5 ACCESS MODE

The Access mode is entered by pressing the +/INC switch from the main menu. The 580B has four access levels, zero through three. Level zero will only allow the operator to log data points and of course to change access levels (only if the access code is known). Level one will also allow the user to change the user identification number. Level two will allow the user complete access to the Parameters mode, and allow viewing of the date and time. Access level three allows complete access.

The access mode has three sections:

1. Access level
2. User identification number
3. Instrument number

Pressing the +/INC switch will advance the 580B to the next section. Pressing the -/CRSR switch will advance the 580B to the previous section.

TABLE OF ACCESS LEVELS

ACCESS LEVEL	OPERATIONS ALLOWED
0	Change access level Log data
1	All above operations View time and date View communication format Display logged data Change user I.D.
2	All above operations Change operating Parameters Reset logged data
3	All operations available

2.5.1 ACCESS LEVEL

The screen will display:

```
ACCESS LEVEL   3
"RESET" TO CHG
```

By pressing the RESET switch the 580B will display:

```
KEY    00003
"RESET" WHEN DONE
```

Please note that in both screens the 3 indicates the current access level and may not necessarily be a three.

In order to change the access level the +/INC switch may be pressed to increment the digit above the cursor and the -/CRSR switch may be pressed to move the cursor. The desired access level should be entered in the right most digit. Note that only access levels between zero and three are legal. The remaining four digits are the access code. The access code will be 0000 when the instrument is shipped. The access code should then be entered. Once this is done press the RESET switch. The 580B will then return to the previous screen.

If the access code entered was not the proper access code, or if the access level was not a legal access level then the access level will not be changed.

The last and most important point regarding the access level is how to change the access code. The access code is the four rightmost digits of the instrument number. The instrument number is only viewable (and therefore only changeable) while in access level three.

2.5.2 USER IDENTIFICATION NUMBER

The screen will display:

I.D.# 014563977
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

I.D.# 014563977
"RESET" WHEN DONE

The user identification number may be changed by pressing the +/INC switch to increment the digit above the cursor and the -/CRSR switch to move the cursor. The user identification number is a nine digit number (just right for fitting a social security number). Once the user identification number has been entered press the RESET switch and the 580B will return to the previous screen.

2.5.3 INSTRUMENT NUMBER

The screen will display:

INSTR # 000000
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

INSTR # 000000
"RESET" WHEN DONE

The instrument number may be changed by pressing the +/INC switch to increment the digit above the cursor and the -/CRSR switch to move the cursor. Once the instrument number has been entered the RESET switch should be pressed. The 580B will then display the previous screen.

When the instrument number is changed it is very important that the last four digits be remembered. These digits are the access code and therefore will need to be known in order to change the access level.

2.6 CLOCK MODE

The Clock mode is entered from the Main menu by pressing the SPKR switch. The screen will display the date and time on the top line. The bottom line will display:

"RESET" TO CHG

By pressing the RESET switch the 580B will display:

"RESET" WHEN DONE

The date and time may be changed by pressing the +/INC switch to increment the number (or in the case of the month the months abbreviation) above the cursor. The -/CRSR switch will move the cursor. Once the proper month has been entered the RESET switch should be pressed. The 580B will return to the previous screen.

The date and time will be maintained even when the instrument is turned off! It is however advisable that the date and time periodically be checked to ensure that it is correct.

2.7 COMMUNICATION MODE

The Communication mode is entered from the main menu by pressing the RESET switch. The Communications mode has four sections.

1. Communicate with printer or computer
2. Display logged data
3. Reset logged data
4. Set communication parameters

Pressing the -/CRSR switch will advance the 580B to the next section.

NOTE: A detailed discussion of communication protocol is given in Appendix A. Further discussion of communication may be found in Section Seven.

2.7.1 COMMUNICATE WITH PRINTER OR COMPUTER

The 580B is capable of communicating with a computer or outputting logged data to a printer. The 580B will display:

COMMUNICATE?

"+" = YES

if the computer format is selected or it will display:

OUTPUT TO PRINTER
"+" = YES

if the printer format is selected. In either case pressing the +/INC switch will cause the 580B to try to establish communication. Pressing the -/CRSR switch instead will cause the 580B to advance to the next section.

2.7.2 DISPLAY LOGGED DATA

If at least one data point has been logged the 580B will display:

DISP. LOG DATA?
"+" = YES

By pressing the +/INC switch the 580B will display the first data point. The date and time which the data point was logged will be displayed on the top line. The bottom line will alternate between the location code and the PPM. Pressing the +/INC switch will advance to the next logged data point. This will continue until there are no more data points at which time the 580B will display:

NO DATA STORED

The MODE/STORE switch may be pressed to return to the Run mode.

2.7.3 RESET LOGGED DATA

The logged data can be erased so that more data points may be logged. The screen will display:

RESET LOG DATA?
"+" = YES

Pressing the +/INC switch will erase all of the logged data points. The 580B will then advance to the next section.

2.7.4 COMMUNICATIONS PARAMETERS

The 580B can be configured to communicate with a printer or a computer. The baud rate may also be set for 9600, 4800, 2400, 1200, 900, 600, 300, or 150 baud. The 580B will display the current communication format (computer or printer) on the top line and the current baud rate on the bottom line. Pressing the RESET switch will cause the 580B to display:

COMPUTER FORMAT
\+ = USE - = NO

Pressing the +/INC switch will select the computer format and the 580B will advance to the baud rate screen (see below). Pressing the -/CRSR switch will cause the 580B to display:

PRINTER FORMAT
+ = USE - = NO

Pressing the +/INC switch will select the printer format and the 580B will advance to the baud rate screen (see below). Pressing the -/CRSR switch will cause the 580B to display the previous screen.

The baud rate screen will display the currently selected baud rate on the top line. The bottom line will display:

+ = USE - = NO

Pressing the +/INC switch will cause the displayed baud rate to be selected and the 580B to show the selected format on the top line and the baud rate on the bottom line. Pressing the -/CRSR switch instead will cause the next lowest baud rate to be displayed.

2.8 BATTERY / CHARGER

The model 580B uses a 1.2 amp hour lead acid (gel cell) battery. There is protection circuitry potted directly on top of the battery. The battery is rechargeable with the charger provided with the instrument. The charger is regulated so that there is no danger of "over charging" the battery. It is suggested that the 580B be charged over the weekend (as well as each evening) during periods of heavy usage in order to ensure maximum battery charge.

SECTION III

ROUTINE MAINTENANCE

The routine maintenance of the 580B involves the calibration of the instrument, the cleaning of the lamp window, and the maintaining of charge on the battery. The following pages give instructions for routine maintenance. Figure 3.1 illustrates the detector assembly.

3.1 LAMP INSERTION AND REMOVAL

3.1.1 REMOVAL

NOTE: The 580B must be off while removing the lamp.

In order to remove the lamp the four screws which hold the case top and bottom together must first be loosened. The case bottom should be placed flat on the table and the top placed on its side next to the bottom.

The high voltage power supply is removed next by loosening the thumb screws on each side and then pulling the power supply towards the rear of the instrument (see figure 3.1). The lamp may now be removed by loosening the lamp nut.

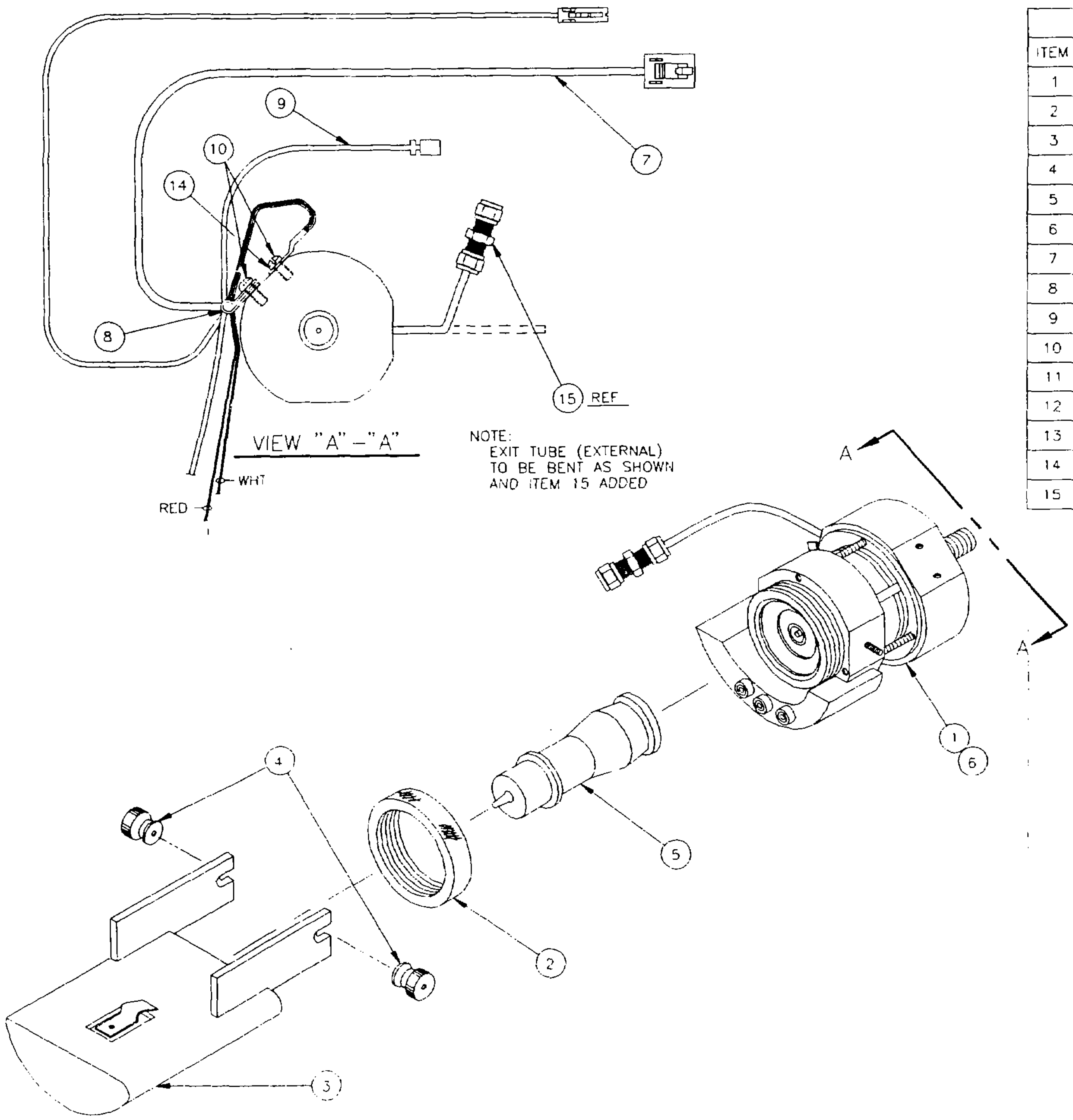
3.1.2 INSERTION

Insertion of the lamp is accomplished by performing the above tasks in the reverse order. The lamp should be placed flat against the o-ring and the lamp nut fastened down in order to create a proper seal. The high voltage power supply should then be inserted and the thumb screws fastened down. There are three pins protruding from the high voltage power supply which should fit snugly into connectors located beneath the detector. The lamp spring (mounted in the center of the high voltage power supply) should make contact with the lamp ring.

3.1.3 LAMP CLEANING

On occasion the lamp should be removed for cleaning. Cleaning of the lamp is accomplished by cleaning the lens surface of the UV lamp. This is accomplished by using the aluminum oxide scouring powder provided with the 580B.

The procedure for cleaning the lamp is as follows. First place a small amount of aluminum oxide scouring powder on the lens of the UV lamp. Next gently scour this lens with a soft tissue or cloth. Scour the lens in a rotary type motion. After scouring the lens surface, gently blow the remaining powder from the lens. Thoroughly wipe the lamp lens with a clean tissue to remove the last traces of cleaning powder. The lamp is now able to be inserted into the detector.



MATERIAL LIST			
ITEM	PART NO.	DESCRIPTION	QTY
1	580B-6003	DETECTOR SUB ASSY.	1
2	580S-2010	NUT - LAMP (13507)	1
3	580S-6019	PWR. SUPPLY ASSY. (13560)	1
4	12082	NUT - KNURLED	2
5	11929	U.V. LAMP 10.0	1
6	580S-6035	DETECTOR WIRING ASSY. (13575)	1
7	580B-6001	BASE HARNESS ASSY.	1
8	4166	STRAIN RELIEF	1
9	580S-6028	SIGNAL CABLE (13568)	1
10	5814	#4-40 X 1/4" BINDER HD. SCREW	2
11			
12			
13	5510	TEFLON TUBING 1/8" 6.5" LG	1
14	5588	#4 INT. TOOTH STAR WASHER	1
15	4417	UNION-2U-316	1

Figure 3.1
Detector Assembly

3.2 CALIBRATION

NOTE: Chapter four should be read before calibrating the 580B in order to gain a better understanding of the concepts behind calibration of the 580B.

The following is a brief discussion of calibration as it relates to different lamps. One of the parameters in the Parameters mode (see Section 2.4) allows selection of lamp setting. The two types of lamps are the 10.0 eV and the 11.8 eV lamp. Whenever a new lamp is used the 580B must be calibrated. This is true even if the new lamp is the same type, e.g., the new and old lamp are both 10.0 eV. This is due to the fact that each lamp will have a slightly different sensitivity.

It is important to note that the 11.8 eV lamp will in general be less sensitive than the 10.0 eV lamp. This is true despite the higher energy level of the 11.8 eV lamp. The 11.8 eV lamp will however "see" certain gases which the 10.0 eV lamp will not. See Table E.1 for a list of common organic vapors and their associated ionization potentials. Any questions regarding the use of the 580B should be directed to Thermo Environmental's Application Laboratory.

The 580B is quite simple to calibrate. A source of "zero air" and "span gas" are all that is needed to calibrate the 580B. The zero air is introduced to the 580B in order to determine the "background" signal. The concentration of the span gas is then selected. The span gas is finally introduced to the 580B. The instrument makes all of the necessary calculations (including linearization) to arrive at a "calibration constant." When in the Run mode the signal is multiplied by the calibration constant in order to arrive at the current PPM.

$$\text{CALIBRATION CONSTANT} = \frac{\text{SPAN PPM}}{\text{SPAN SIGNAL} - \text{ZERO SIGNAL}}$$

$$\text{PPM} = (\text{SPAN SIGNAL} - \text{ZERO SIGNAL})\ \text{CALIBRATION CONSTANT}$$

NOTE: The PPM is then multiplied by the RESPONSE FACTOR before being displayed. Chapter four explains the use of response factors when calibrating.

Section 2.4.8 gives a detailed explanation of which buttons to press in order to calibrate the 580B. The flow chart at the back of this manual may also be helpful.

3.3 CHARGE

When there is a flashing "B" in the lower left corner of the display (while in the run mode) the battery is low. The battery is recharged by plugging the charger into the RUN/CHARGE plug at the rear of the 580B. The instrument runs while it is charging.

SECTION IV

CALIBRATION

4.1 GENERAL

The Model 580B Organic Vapor Meter is indeed a quantitative instrument and can certainly be used as such. It makes use of the Photoionization Detection System using a lamp with an ionization energy of 10.0 eV which is standard in the Model 580B. Almost all organic materials will be ionized at this energy level. There are some organic materials, such as a few of the freons, methane, ethane and propane that are not ionized and thus will not be detected. The ionization potentials for the various organic materials will simply tell whether the material will be detected by the Photoionization Detector. It does not give any clue as to the sensitivity of the detector for that particular material. Certainly, different organic vapors will have different sensitivities. It is important to understand that the Model 580B does indeed sense most organic vapors and that its response to these different organic vapors will be different.

In this section of the manual, the aspects of calibrating the Model 580B for various vapors will be discussed. In the following section discussing applications, various ways of using the features of the Model 580B will be explained along with the various methods for calibration of the 580B. There will also be applications of the Model 580B in specific instances where the organic vapors or the mixtures of organic vapors are completely unknown. The 580B can be an extremely useful tool, even in areas such as those.

4.2 FACTORY CALIBRATION TEST OF THE MODEL 580B

The Model 580B has been tested for calibration and linearity tested at the factory. The particular gas chosen for this calibration is isobutylene. The Model 580B has good response for isobutylene. Isobutylene standards prepared in air are relatively stable with time, undergoing no serious adsorption or reaction problems. The test information is included in the instrument packet. In addition to the above test a benzene standard is also run. It is important to note that the instrument was not calibrated. It was tested for calibration. Therefore, it should be calibrated by the operator before use.

4.3 METHODS OF GENERATING CONCENTRATIONS OF VARIOUS MATERIALS IN AIR

This section is not intended to be all inclusive as far as the preparation of gas and vapor standards in air are concerned. Only those methods that have been found most practical for the calibration of the 580B are discussed here. There are basically two types of standards, cylinder and bag.

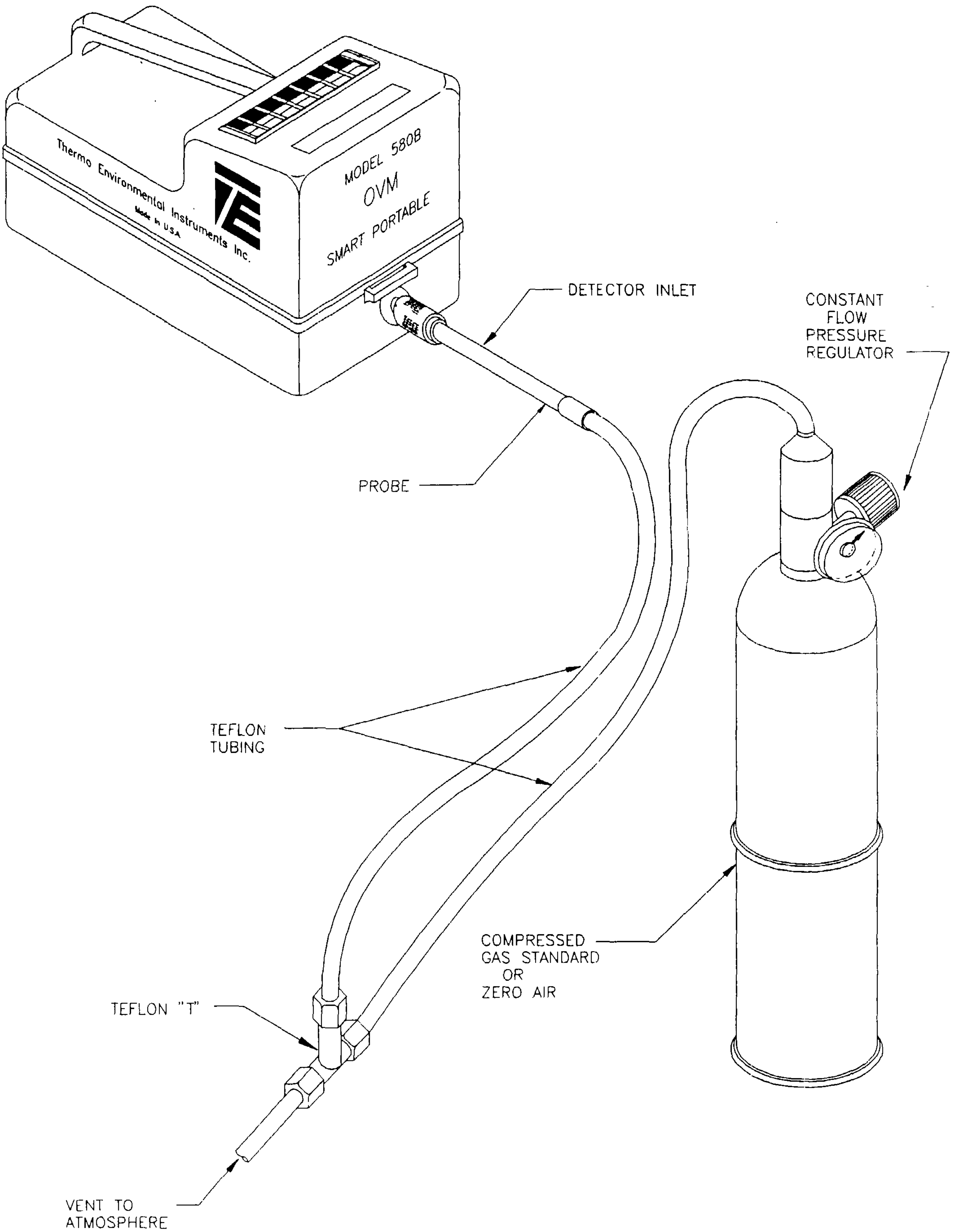


Figure 4.1
Cylinder Calibration

4.3.1 CYLINDER STANDARDS

Certainly commercially available standard cylinders of gaseous materials in air offer the most convenient method of calibration. However, these are static standards. Standards prepared in this fashion in air for vapors of various organic liquids often show concentration reduction with time due to adsorption problems. In general, gases when mixed with air will maintain their concentrations with time since adsorption is generally not a problem.

However, some gases are sufficiently reactive that chemical reaction of the gas will cause a reduction of it in air. These precautions must be observed when using commercially prepared standards for calibration of the Model 580B. It is for this reason that isobutylene in air was chosen as a reference standard for factory calibration. TEI offers a cylinder standard which includes both zero and isobutylene standards. A constant flow pressure regulator sets the flow needed for calibration of the 580B. Figure 4.1 illustrates the physical calibration procedure. The inlet to the 580B is connected to the "T" as shown. It is important that this connection is tangent to the gas flow. The "T" is connected to the regulator on the standard cylinder. It is important that a length of tubing is attached to the "T" location. This prevents diffusion of ambient air into sample line. The regulator and tubing assembly will have to be moved between both the zero air and standard cylinder.

4.3.2 BAG STANDARDS (ISOBUTYLENE)

Bag standards can be prepared in a laboratory and in general are reasonable ways of calibrating the Model 580B. However, it is important that these standards be used shortly after their preparation to reduce the significance of any adsorption problems. Static standards prepared for calibration of the Model 580B are best prepared in collapsible plastic bags. This is opposed to a fixed volume container. The sampling rate of the 580B, which is 500 ml/min, requires an appreciable amount of sample. Even one minute's sampling out of a fixed container will remove 500 ml/min from it. This should not significantly reduce the pressure inside the container. Thus, the collapsible bag provides the best means as opposed to a fixed volume. A 5 gallon polyethylene bag is a convenient size to use for the preparation of static standard.

A tube is inserted into the opened end of the bag and the bag opening then sealed around the tube. The tube should have a cutoff valve or some means of closing the volume of the bag. The volume of air introduced into the bag must be measured. This is most conveniently measured by a wet test meter. However, a source of air flowing through a flow meter can be used if the flow can be held constant, then time is a measure of the volume of the air placed into the bag. All air is expelled from the bag by completely collapsing it prior to connection to the source of air.

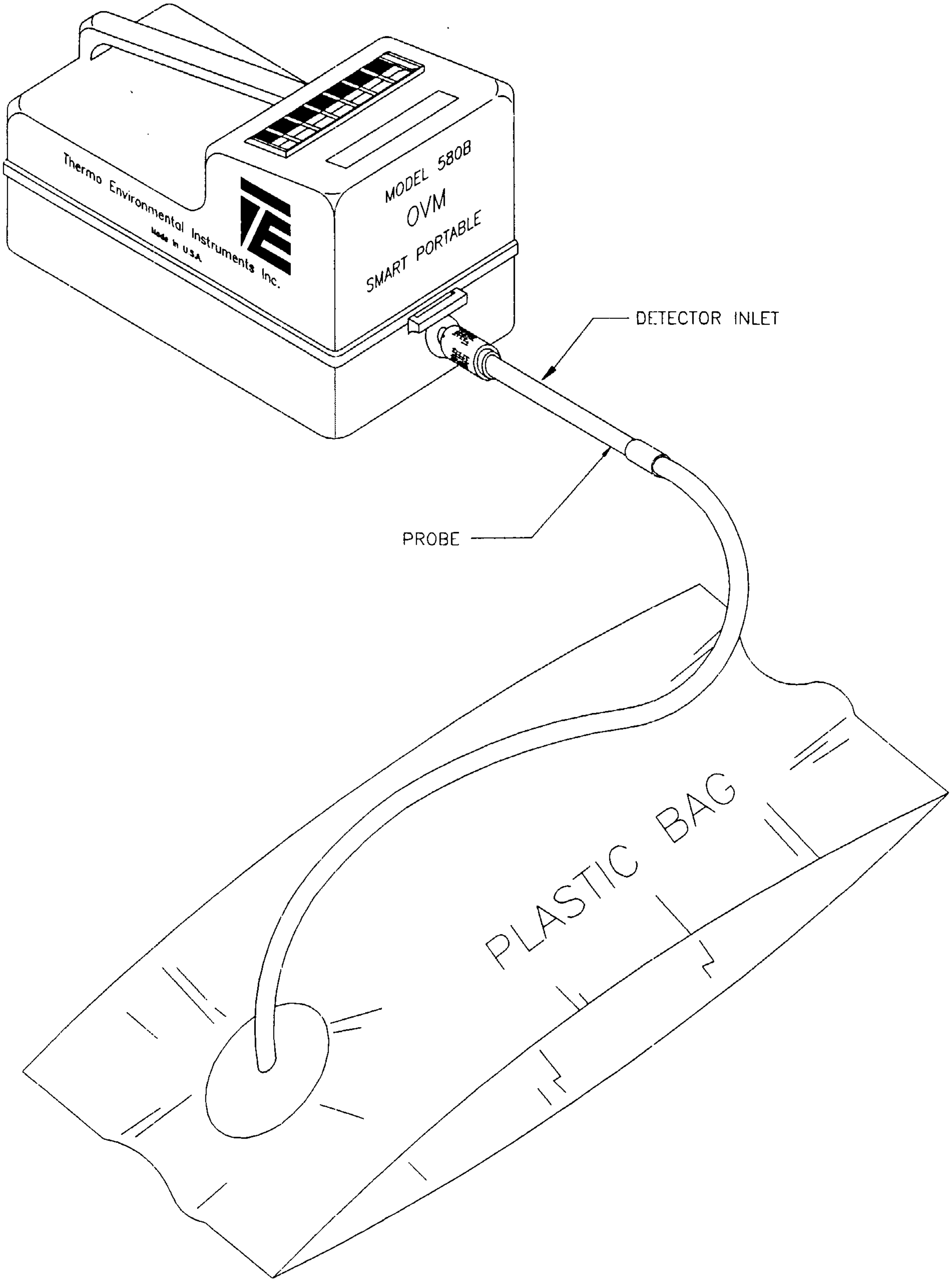


Figure 4.2
Bag Calibration

It can then be connected to a wet test meter or flow meter via a short length of rubber tubing hooked to the plastic tube of the bag. The air flow is started into the bag at a rate of approximately 5L/min. A total of 10 liters is a convenient volume for a 5 gallon bag. This would mean approximately 2 minutes for filling the bag. Figure 4.2 illustrates the physical configuration needed to develop bag standards.

For gaseous samples, the trace organic will be added via a glass hypodermic syringe. The 1 cc Tuberculin syringe is a convenient size. For an isobutylene standard, the 1 cc syringe is flushed with pure isobutylene and then filled to the 1cc mark. While the air is flowing into the plastic bag, the short piece of rubber tubing is pierced by the needle from the 1 cc syringe and the plunger slowly depressed such that the 1 cc of isobutylene is added to the air flowing into the plastic bag. When 10 liters of air have been added to the plastic bag, the flow is immediately stopped and the valve on the tube or the closing clamp is applied to contain the air and isobutylene within the plastic bag. It is best at this stage of the procedure not to rely solely on the diffusion of isobutylene to form a uniform mixture inside the plastic bag. Slight kneading of the plastic bag will hasten the mixing of the isobutylene in air. The plastic tube from the bag is then connected to the probe on the Model 580B via a short length of rubber tubing and the valve on the plastic tube immediately opened. The Model 580B withdraws a sample from the bag at the sampling rate of 500 ml/min. Thus, 10 liters of sample in the bag will provide approximately 20 minutes. Certainly the calibration of the 580B can be accomplished in a shorter period of time. The concentration of isobutylene in ppm by volume will be equal to the sample size, which was 1 cc, divided by the volume of the bag in liters, which would be 10 liters, times 1000. In this particular instance, the concentration would be:

$$\text{Conc (ppm by Vol)} = \frac{\text{1cc Isobutylene x 1000}}{\text{10 L Air}} = \text{100 ppm}$$

4.3.3 BAG STANDARDS (ORGANICS)

On occasion there is the need to prepare standards other than the normal calibration standard. As mentioned previously, isobutylene was chosen as a standard because of its stability. If other standards are to be used, it is best to develop a relation of the other standard to a standard of known stability like isobutylene. If this procedure is followed, a response factor can be developed by comparing the other organic standard to isobutylene this technique will be discussed in a later section. The following is a suggested technique for preparing other standards.

For organic materials, which are normally liquids at room temperature, the procedure is essentially the same except that an extremely small liquid sample is injected into the flowing air stream rather than the gas sample. This technique works well only for relatively volatile organic materials. The flowing air stream must vaporize all of the material or the calculation will be off. If the material is not rapidly volatile in that flowing air stream, the liquid should be injected through the surface of the plastic bag. Immediately after withdrawing the needle, the hole in the plastic bag should be covered with a piece of plastic tape.

Again, significant kneading of the bag will hasten the evaporation of the sample and mixing of the vapor into the air to provide homogeneous samples. The introduction of this sample into the 580B is the same as before. The calculation of the concentration of the vapor in air is a two-step procedure whereby the small volume of liquid injected into the air stream and into the plastic bag is converted to a volume of vapor. This volume of vapor is then used in the same manner as the volume of gas in the case of isobutylene. The following equations apply:

$$\text{Volume Vapor (uL)} = \frac{\text{Liquid Volume (ul)} \times \text{Liquid Density} \times 24.45}{\text{Molecular Weight}}$$

The above equation gives the vapor volume at atmospheric pressure (760 torr) and 25° C (77F).

Then:

$$\text{Concentration (ppm by Volume)} = \frac{\text{Vapor Volume (ul)} \times 1000}{\text{Air Volume (liters)}}$$

The following is a sample calculation for benzene:

Liquid Volume = 2 ul

Benzene Density = 0.879 g/cc

Molecular Weight Benzene = 78.1

Air Volume = 10 Liters

$$\text{Vapor Volume} = \frac{2 \times 0.879 \times 24.45}{78.1} = 0.55 \text{ ul Benzene Vapor}$$

$$\text{Conc} = \frac{0.55 \times 1000}{10} = 55 \text{ ppm (vol)}$$

The syringe used for the measurement of liquids in this particular instance is a small volume-type such as those manufactured by the Hamilton Company. A convenient size syringe is the 10 microliter volume.

4.4 580B CALIBRATION

The following procedure is applicable for both Cylinder and Bag Standards. The sequence requires both Zero gas and Span gas to be used. Span gas can be either contained as a cylinder or bag, in either case the exact concentration used must be known. This concentration will be entered to the 580 when the program provides its entry. With respect to Zero gas, there are several choices. Obviously a certified zero air standard in a cylinder presents no problem. Another choice would be to build a zero air standard in a bag. This can be simply accomplished with the set-up in Figures 4.1 and 4.2 using a charcoal scrubber to remove all the hydrocarbons present in the air. Charcoal does not absorb Methane; this does not cause a problem because the PID does not respond to it. Another approach which could be used in an emergency is to use room air unscrubbed.

This is acceptable if you know that there are no hydrocarbons present or they are exceptionally low in concentration. However, it is not recommended as a standard practice. The physical set up for cylinder calibration is illustrated in Figure 4.1; bag calibration in Figure 4.2.

4.4.1 CALIBRATION ROUTINE

(A) Set-up calibration assembly with zero air cylinder or bag as described in Figures 4.1 and 4.2.
(B) Model 580B set-up and zero calibration.

1. Power-up instrument using power plug.
2. Depress ON/OFF Key to ignite lamp and initiate sample pump.
3. Depress MODE/STORE Key.
4. Depress-/CRSR Key in response to LOG THIS VALUE? Prompt.
5. Depress-/CRSR Key to select Parameters Mode from the Main Menu.
6. Depress +/INC Key to advance thru the Run Mode selection parameter prompt.
7. Depress +/INC Key to advance thru the Auto Logging Mode selection parameter prompt.
8. Depress +/INC Key to advance thru the Average Time selection parameter prompt.
9. Depress +/INC Key to advance thru the Alarm Setting parameter prompt.
10. Depress +/INC Key to advance thru Lamp Selection parameter prompt.
11. Depress +/INC Key to advance thru Response Factor Setting parameter prompt.
12. Depress RESET Key to initiate calibration sequence.
13. Depress-/CRSR Key to decline restoration of the backup calibration.
14. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet as illustrated in Figure 4.2.
15. Introduce Zero Air to Model 580B by opening flow regulator.

16. Depress RESET Key to "Zero" Model 580B.
17. Close Flow Regulator.

(C) Span Calibration - assuming that the Span gas has a concentration of 250 ppm isobutylene the following procedure is followed:

18. Simultaneously Depress RESET and -/CRSR Keys to activate the movable cursor.
19. Repeat Step 18 until the cursor is at the ones place.
20. Simultaneously Depress RESET and +/INC Keys to increment the ones place value.
21. Repeat Step 20 until the ones place value reads 0.
22. Repeat Step 18 to move cursor to the tens place.
23. Repeat Step 20 until the tens place value reads 5.
24. Repeat Step 18 to move the cursor to the hundreds place.
25. Repeat Step 20 until the hundreds place value reads 2.
26. Repeat Step 18 to move the cursor to the thousands place.
27. Repeat Step 20 until the thousands place value reads 0.
28. The LCD should now read:

    SPAN PPM = 0250
    "+" TO CONTINUE

29. Depress +/INC to accept the span conc. value.
30. Connect isobutylene cylinder (250 ppm) to calibration tubing assembly.
31. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet.
32. Introduce isobutylene standard to Model 580B by opening flow regulator.
33. Reset key to "CALIBRATE" Model 580B.
34. Close Flow Regulator.
35. Depress +/INC. Key in response to "RESET" TO CALIBRATE message.
36. Depress MODE/STORE to return to the Run Mode.

The instrument has been calibrated and is ready to make measurements.

4.5 DETERMINATION OF RESPONSE FACTORS

As mentioned above, the Model 580 can be calibrated with isobutylene but be set to read correctly, the concentration of another substance. This is done by using the Response Factor that is set in the parameter routine. The default for the response factor is 1.0. The Response Factor is the number that is multiplied by the measured concentration to obtain the correct concentration of the measured component. If the chemical to be measured is less sensitive on a PID than the standard, (usually isobutylene) then the Response Factor is greater than 1.0. If it is more sensitive than the standard then the Response Factor is less than 1.0.

The reason for a Response Factor is practicality. If it is know that the sample to be measured contains only benzene and therefore the user would like to read benzene concentration directly, there are two approaches. The user could make a bag standard daily of benzene vapor in air and calibrate the 580 directly. Or the Response Factor could be used. In the latter case a bag with benzene is made only once for comparison to a cylinder of a stable standard (such as isobutylene). Then daily, the Model 580 is calibrated with the cylinder standard, a simple operation compared to the work of preparing a bag standard.

As an example, if the bag containing 55 ppm benzene in air as prepared above were measured in a 580 calibrated against isobutylene, the concentration might have been read as 91 ppm. thus the 580 is more sensitive for benzene than for isobutylene.

The Response Factor can now be calculated as:

$$\text{Response Factor (RF)} = \frac{\text{Factor STD Concentration}}{\text{580 Reading of Factor STD}}$$

$$RF = 55/91 = 0.604$$

When 0.60 is entered into the 580 as the Response Factor, the 580 will read 55 ppm for the bag.

Now the 580 need only be calibrated using an isobutylene standard and a Response Factor of 0.60 to correctly respond to benzene.

SECTION V

APPLICATIONS

5.1 GENERAL

This section discusses six applications which were done on the old model 580. These applications are discussed as they relate to the model 580B. The following applications of the Model 580B are given to show some different uses and means of calibration of the Model 580B in various practical applications. It is certainly not intended to be an exhaustive list of the uses of the Model 580B. In each situation, the stress is placed on the means of calibration and the interpretation of the readout of the Model 580B. Since the Photoionization Detector responds to virtually all organic materials and since its response varies for the different organic materials, questions can certainly arise as to just how the numbers presented on the digital display relate to anything meaningful. These applications will hopefully illustrate several ways in which these numbers can be quantitative and also illustrate uses of the 580B where accurate quantitation may be impossible.

5.2 VINYL CHLORIDE MONOMER IN REACTION VESSELS.

This particular application involved measuring the vinyl chloride content in vinyl chloride polymerization vessels following the polymerization reaction and the removal of the polymer slurry. Any residual vinyl chloride left in the reaction vessel has to be flushed and scrubbed prior to the opening of the vessel. The vinyl chloride content must be below a certain prescribed level prior to this opening. The reaction vessel is flushed with nitrogen to remove the vinyl chloride from the vessel and purge it through the filter media which remove the vinyl chloride from the nitrogen stream for recovery. During this particular operation, it is known that vinyl chloride monomer comprises significantly more than 90% of the entire organic material. In this instance, if the Model 580B is calibrated for vinyl chloride measurement, indeed the readout will be virtually the true vinyl chloride concentration inside the reactor vessel. The nitrogen exit stream prior to the vinyl chloride recovery was the point used for the analysis.

Since the plant was a considerable distance from the laboratory and since the study would require a significant period of time encompassing several weeks, it was decided to calibrate the Model 580B with the isobutylene reference standard and determine a response factor setting for a vinyl chloride standard in the laboratory.

With the response factor set at 1.0, the instrument was calibrated with isobutylene. The Model 580B was then presented with a known concentration of vinyl chloride monomer in nitrogen. The response factor for the vinyl chloride was then set in order for the Model 580B to read the correct concentration of vinyl chloride in the nitrogen. Static standards of vinyl chloride are very definitely not stable with time due to the reaction of the vinyl chloride with itself. Thus, standards need to be prepared fresh each time vinyl chloride is to be used to calibrate an instrument. Since bag preparation, which was the technique used for this laboratory calibration of the 580B, would have been inpractical at the plant; the use of a stable reference standard of isobutylene was chosen. Thus, at the plant site, the Model 580B could be calibrated using the isobutylene standard from a cylinder. This of course, greatly simplified the plant use of the Model 580B. This relationship to a reference standard reduces the time and equipment required at the plant such that the survey of all of the reactor vessels was completed in a short period of time with the items established for the nitrogen flush of the reactor vessels prior to opening the reactor vessels.

It is important to note that when the response factor setting was determined in the laboratory, nitrogen was used as the matrix for the bag preparation of the vinyl chloride standard. If air were used a different setting (higher) would be obtained. Since the sample was in a nitrogen matrix so should be the standard. Note also it is not necessary to have the isobutylene standard in nitrogen. In addition to correcting for differences in response between isobutylene and vinyl chloride, the response factor setting can also adjust for the different readings in nitrogen and air.

5.3 MONITORING ISOLATED PLANT AREAS FOR TOLUENE AND METHYL ISOBUTYL KETONE.

Two areas of an extensive plant operation were required to be monitored for the levels of methyl isobutyl ketone and toluene. Both of these areas were relatively isolated. In one area, methyl isobutyl ketone was the only solvent to which the atmosphere was exposed other than the potential leaks that might occur in process equipment in that same area. There were no other known solvents in use in that area and the ventilating system in effect isolated this area from other areas in the plant. In the second area, toluene had just very recently been substituted as a solvent in place of benzene due to the lower TLV for benzene. Average workplace levels were therefore needed for the toluene concentration in this work area. Again, toluene was the only solvent in this area and there was no other process equipment in the immediate area for even possible leak problems.

Notice that in both of these areas in the plant, it is certainly known from the processes occurring in that area and its relative isolation from the other areas in the plant, exactly which organic vapors will be by far the predominant vapors in the workplace air. In many instances, by simply knowing the processes involved and the chemicals in use in those processes, the qualitative aspects of the environment can indeed be established without the use of instrumentation. This is one of the most overlooked aspects in establishing what organic vapors are present in the environment. It simply involves determining what are the possible organic vapors that can be present. In general, this narrows it to several and in many cases, a single organic vapor.

In these cases, the Model 580B can be calibrated specifically for these materials and will provide quantitative data on the levels of these materials in the workplace environment. In this particular instance, even though the laboratory to be used for the calibration of the Model 580B was at the plant site, it was desired to use a single 580B to monitor both work areas sequentially and several times throughout the course of a single day. This was to be done over a period of time to establish the variations of both methyl isobutyl ketone and the toluene in these work areas. In this particular instance, changing the response factor setting can avoid considerable calibration changes, as one moves from determining concentrations of methyl isobutyl ketone to the area where one is measuring the concentrations of the toluene vapor.

For calibration, the Model 580B response factor was set at 1.0 and the instrument spanned properly using a known reference standard of isobutylene. The Model 580B was then presented with a flowing air stream containing toluene vapor as generated in the Thermo Electron Model 360 using a toluene diffusion tube. The response factor was then adjusted so that the readout of the Model 580B corresponded to the toluene concentration in this standard.

The Model 580B was then presented with a flowing air stream containing methyl isobutyl ketone. This also was generated via a diffusion tube in the Model 360 Standards Generator. Once again, the response factor was adjusted so that the digital display gave the correct reading for the concentration for the methyl isobutyl ketone presented to the instrument.

With the instrument then calibrated with the reference isobutylene standard and knowing the proper settings of the response factors for methyl isobutyl ketone and toluene, the Model 580B was then ready for its plant survey. The area containing the toluene was monitored for a period of time with the toluene levels as noted by the 580B being recorded.

The response factor was set for this toluene reading. The instrument was then moved directly to the methyl isobutyl ketone area and the response factor adjusted to read methyl isobutyl ketone. The 580B was then able to read directly the methyl isobutyl ketone concentration in the second area. There was the possibility of leaks in process equipment in this particular area. The area in general was surveyed. If significant changes in the reading of the 580B were observed, the 580B was used as a leak sourcing instrument as described in a later section. In this fashion, it could be determined if some of the varying concentrations in this area were indeed coming from a leak in the process equipment. During the survey of this particular area, no leaks from process equipment were observed, therefore, the readings obtained on the 580B could indeed be considered the methyl isobutyl ketone concentration in this particular area.

Throughout the survey of these two workplaces, the 580B could move back and forth rapidly due to its portability and could be, in effect, recalibrated for each of the two different vapors by the mere setting of the response factor.

5.4 PETROLEUM ETHER VAPORS IN WORKSPACE AIR.

A given workplace was using petroleum ether as a paint solvent and for cleaning purposes. It was desired to quantitate the amount of petroleum ether in the air being recirculated in this particular area. Petroleum ether is a distillation fraction from crude oil. Its boiling point is slightly lower than the boiling point of gasoline. This means that petroleum ether is not a single chemical entity, but a multitude of hydrocarbons in a certain boiling range fraction. Reasonable quantitative data can be obtained here without knowing the exact chemical composition of each hydrocarbon that composes petroleum ether . For this purpose, the Model 580B can be used to measure these vapors. The 580B is initially calibrated with the response factor set at 1.0 using a reference standard of isobutylene.

The 580B is calibrated on isobutylene. Then a bag sample is prepared, as detailed above, for the quantitation of the instrument to measure the petroleum ether. In this particular instance, the petroleum ether is injected into the bag in the same fashion that liquid samples are injected. The calculation, however, has to change slightly because the ppm on a volume basis cannot be calculated without knowing the exact chemical composition of the petroleum ether. However, in a situation such as this, one can still quantitate it on a weight basis of the solvent in air. The equations below show this calculation.

$$\text{Weight Vapor (mg)} = \text{Liquid Volume (uL)} \times \text{Density g/ml}$$

$$\text{Conc (mg/m3)} = \frac{\text{Weight Vapor (mg x 1000)}}{\text{Air Volume (liters)}}$$

For Petroleum Ether In This Example:

Liquid Volume = 3 uL

Petroleum Ether Density = 0.66 g/ml

Air Volume = 10 liters

Vapor Weight = 3 uL x 0.66 g/mL = 1.98 mg

$$\text{Conc} = \frac{1.98 \times 1000}{10} = 198 \text{ mg/m3}$$

This sample in the bag is then presented to the Model 580B and the response factor adjusted so that the digital readout on the front panel provides the proper reading in mg/m3. The setting of the response factor that is needed for this reading is noted. The Model 580B can now be used to monitor reasonably quantitatively the petroleum ether in the workplace environment. Any further calibration of the instrument can be done using the reference standard of isobutylene. This is a reasonably accurate way of giving quantitative information on the amount of solvent in air even though the results are not reported in ppm on a volume basis.

This technique can be used in general when the solvents are a mixture of materials which in general will probably be petroleum distillation fractions. It would certainly also be used in the case of gasoline vapors in air. Notice from the equations used versus the equations for determining the ppm concentration in bag samples for pure liquids, the only real thing missing is the molecular weight of the material. It may be possible to assume an average molecular weight of the solvent mixture and actually report a ppm by volume basis.

5.5 LEAK SOURCING

In this particular instance, the Model 580B is to be used for determining the presence, or absence of leaks in a chemical process plant. The Model 580B is uniquely adapted to this particular operation due to its light weight. In this particular instance, it is not necessary to accurately attempt to quantitate the readings from the Model 580B. It will be used simply to determine presence of leaks and to locate these leaks.

The Model 580B is simply calibrated against a reference standard of isobutylene as normal. No further calibration is used. It is not necessary to know the particular chemicals flowing in the different pipes or what they are in the various reaction chambers. It is only necessary to know that these materials will have some response on the Photoionization Detector. That is, that their ionization potentials are below the energy of the lamp. The standard probe of the Model 580B, with the 580B fully operational, is then simply moved along the various pipes and reactor vessels in the chemical process.

All seals are traced clear around the seal with the end of the probe. As one approaches a leak, the concentration of the organic materials in the air being sampled by the Model 580B will increase significantly. The point of maximum reading will indicate the point of the leaks. As one moves further away from the leak, the concentration of the organics in air will certainly decrease. In this very rapid fashion, the presence of leaks can be detected and their source fairly accurately pinpointed so that the leak can be repaired.

In many instances, it is not necessarily the workplace hazards of these leaks that is important, but the economics of the chemical process itself. In this instance, as in many instances, the exact composition of the organic materials being measured is really unimportant to the successful use of the 580B in a specific application. Also the exact numbers that are displayed on the digital readout of the 580B are unimportant. It is only relative magnitudes that are important in this instance.

5.6 AFTERBURNER EFFICIENCY

In a particular coating process, the material, after it has been coated, is passed into a dryer where the solvents of the coating are removed. These solvents are then vented into a stack. To reduce the hydrocarbon emission from this plant, an afterburner had been installed to combust the organic solvents from the coating prior to release to the atmosphere. It is important to determine the efficiency of this afterburner and to follow the efficiency of the afterburner to avoid dumping excess solvent into the atmosphere and, thus, become subject to pollution fines.

The Model 580B is ideally suited to this type of operation. Again, it will be unnecessary to know the exact chemical composition of the coating solvent. The Model 580B is simply standardized against the reference standard isobutylene in the usual fashion.

The Model 580B is then connected to sample the stack gas in the dryer prior to the afterburner, noting the steady state number displayed on the digital panel meter. The 580B is then connected to the exhaust gases from the stack following the afterburner.

Again, the steady state number, as displayed on the Model 580B, is noted.

The reading prior to the burner minus the reading after the burner divided by the reading prior to the burner times 100 gives efficiency of the afterburner in the stack. This number is quite accurate, even though the Model 580B was not calibrated specifically for the solvents or solvent mixture used in this particular coating operation. The individual readings before and after the afterburner may not have the exact quantitative relationship to the actual amount of material, but their ratio will be accurate since basically the same chemical or mixture of chemicals is being measured before and after the afterburner.

5.7 SAMPLE COLLECTION OF UNKNOWN ENVIRONMENTS

The Model 580B can also be used in areas where organics are known to be present, but perhaps the exact composition of the environment is not known. This may be due to several solvents being in the same general workplace or various separate processes occurring in that same workplace, all of which could and possibly are admitting organic vapors. In plant areas such as these, the Model 580B can still be extremely useful.

The 580B is calibrated against a reference standard of isobutylene, as mentioned above. The 580B is then used as a survey tool throughout the entire plant area. The readings are logged, especially changes in these readings. The exact numbers displayed will not, in general, be a quantitative measure of the ppm of the organic vapor since it is impossible to know what organic chemical or mixture of chemicals should be used for the calibration. When high readings are obtained on the Model 580B, an evacuated sample bag can be connected to the rear of the 580B at the sample exhaust port. This bag could be virtually identical to the type of bag used for standards preparation. The Model 580B is sampling the atmosphere at the rate of 500 ml/min. The detection system of Photoionization is a nondestructive system such that the sample that is exiting the Model 580B is indeed the same material that is giving the readings on the 580B. When the 580B is seeing high readings, this is the time the bag is connected to the rear for sample collection. The bag, if the same type is used for sample preparation, can hold approximately 10 liters of air sample; which would permit a sampling time of 20 minutes.

This bag sample can then be closed on removal from the 580B and transported to a laboratory for subsequent analysis to identify the individual chemical compounds present in the sample causing the high readings and to ascertain if the workplace environment is harmful at those high readings.

The use of the Model 580B coupled with the bag collection ensures that the sample that is returned to the laboratory for analysis is a sample containing the desired organic vapors. This is assured because the bag collection is used only when the Model 580B is detecting high levels of organic vapor in the environment. This is an instance of the use of the Model 580B when the type of organic vapors are not known and it is desired to know them. The 580B has a very useful function even in these areas. It should be noted that a charcoal tube could be connected to the rear of the 580B as well as an evacuated plastic bag. The charcoal tube will pass the bulk of the sample, which is air, and adsorb the organic vapors. This charcoal tube can be returned to the lab for subsequent analysis for both a qualitative identification of the materials present as well as a quantitative measure of their levels.

SECTION VI

COLLECTION TECHNIQUES

6.1 GENERAL

As mentioned in the Application Section, it is possible to use the 580B in completely unknown areas as far as the organic vapors present are concerned and still obtain meaningful data. One of the techniques described here is the use of the 580B as a means of collecting the representative samples for further identification in the laboratory regarding the specific organics that may be present in addition to their concentrations.

Two techniques were mentioned in the section under the heading "Sample Collection of Unknown Environments". One of these techniques involves the use of a bag for collection and the other involves the use of charcoal tubes as a means of trapping organic vapors. In this section, each of these techniques will be explored in further depth as to the proper way of using the 580B to collect the samples for subsequent analysis. These collection techniques are quite useful when one is using the Model 580B simply as a survey instrument. When readings on the 580B become quite high in certain areas, it is impossible to determine the exact source of the high readings to perhaps pinpoint the specific organic chemical giving rise to the reading. One may very well want to identify what the chemical or chemical mixture is that is providing the high reading. This will have to be done with instrumentation significantly more sophisticated than the Model 580B; namely, an instrument that can provide specificity as well as qualitative identification. A Gas Chromatograph is such an instrument.

If it is desired to collect some of the air to send to a laboratory for further analysis, one needs to be sure that the proper samples are taken at the proper time. This means simply that one needs to be assured that the sample sent to the laboratory is indeed a sample that has a high concentration of organic vapor present in the sample. The 580B is used to indicate the presence of the high level organic vapors. The sample then is gathered at the exit port of the 580B when the 580B is reading high values. This assures that the sample sent to the laboratory does indeed have the high level vapors present in it. This generally simplifies the sampling technique of the environment and reduces the number of samples and, therefore, the expense needed to accurately identify the organics present and to quantitate them in a laboratory.

Two design features of the Model 580B make this type of operation possible. The first is that the detection system used in the Model 580B is the Photoionization Detector which is basically a nondestructive detector. Thus, the instrument is able to sense the organic vapor using the detector and virtually the same concentration of the same materials exits the detector as entered it. This does make it possible for the collection of the exact sample contributing to the high readings.

The second feature of the 580B that allows this sample collection is that a positive displacement pumping system is used to draw the sample into the Model 580B. It is a very simple procedure then connect to the exit of this positive displacement pump and trap the sample exiting the 580B after it has passed through the detector.

6.2 BAG SAMPLE COLLECTION.

One of the most convenient ways to sample the environmental air is to simply trap the entire air sample in a collection bag. As discussed before, the bags used for the calibration of the Model 580B, as discussed under the Calibration Section, can certainly be used for collection of the air samples. There are several precautions that must be mentioned immediately relative to the use of bag sample collection. When a bag has been filled with air that has organic vapor in the air sample, the organic vapor molecules will absorb onto the inside surface of the bag. This adsorption will begin immediately on introduction of the air into the bag. It will continue to progress with time until the vapor molecules that adsorb onto the wall of the bag are in equilibrium with the vapor molecules in the air. This equilibrium depends very strongly on the bag material and the chemical entity of the vapor itself. The ambient temperature also has some effect.

As mentioned under the Calibration Procedure, when one is preparing a known vapor concentration in a bag, the bag should be analyzed very rapidly after its preparation to ensure proper calibration of the instrument. The technique here is to use the standard prepared in this fashion as soon as possible such that the adsorption that has occurred is an absolute minimum amount. This adsorption becomes a bit more serious problem in using bags for sample collection. The first problem is simply when one is reusing the bag, one has to be sure that the sample contained in the bag previously has been completely desorbed from the wall. This, in general, can be checked by using clean air to fill a bag allowing the bag to set for a short period of time, about 1 hour, and then analyzing the air in the bag. If on using the 580 to analyze this air, it shows measurable organics, then the air in the bag should be dumped and new air introduced and allowed to set for the same period of time. There will be a reduction of organic vapor on the second go-around.

If it is still too high, this procedure is repeated until the bag shows virtually no organic vapor. The bag can be evacuated and reused.

The other problem associated with adsorption and sample collection is that the sample that is collected in the bag must be analyzed as soon as possible after collection if one is going to determine quantitatively the amount of organic vapor in that bag sample. The longer the sample stays in contact with the bag, the greater the adsorption will be of the organic vapors on the surface of the bag and, therefore, the lower the concentration of the organic vapors in the air sample.

If one is interested here in only doing a qualitative analysis of the organic vapors, that is identify what vapors are present in the air sample, the bag certainly is a convenient way of taking the sample. If one in addition to getting the qualitative analysis desires to quantitate one or more of the specific organic vapors in the sample, the bag sample should be analyzed within an hour of taking this sample. If the bag sample cannot be analyzed this soon, it is recommended that one use the charcoal tube technique explained in the next section.

There are two considerations to be given relative to the size of the bag and, therefore, the size of the sample taken. The first consideration is the amount of sample needed by the laboratory for its analysis. If the analysis is to be done by gas chromatography directly on the air sample, in general only 1 to 5 mL of sample would be required for the analysis. Therefore, this does not become a major consideration here. If, however, other analytical techniques were to be used that would require significantly higher volumes of sample, this should be taken into account.

The other consideration is the sampling time. The Model 580B samples at the rate at which the bag attached to the exit port of the 580B will be filled. If the bag can conveniently hold 10 liters of air, this means that the sampling time can be up to 20 minutes. In general, collection techniques using the Model 580B are not intended to supply a four or eight hour integrated sample. They are used simply to help identify the materials contributing to a high concentration and possibly the analysis of individual toxic organic vapors in that particular air sample. Thus, a 20 minute limitation on sampling time should not be too severe.

Certainly larger bags could be used on the exit of the 580B, allowing up to several hours of sampling time should this be desired. The difficulty then becomes that the bags are quite large and physically become difficult to manipulate. It was recommended back in the Calibration Section that perhaps a 10 liter bag would certainly be the convenient bag for the calibration of the 580B. It would appear to be also a convenient bag for collection of the samples. For this purpose, a bag that has no adsorbed vapors on the interior surface is evacuated and closed to the atmosphere. Several of these bags could be carried in a very small container. When the Model 580B is reading high values, and it is impossible to determine the source of the high values, then a bag can be connected to the exit port of the 580B and immediately opened to accept the sample exiting the 580B. The bag is kept connected to this exit as long as the 580B is giving high readings or until the bag has reached its volume capacity. At this point, the bag is removed from the exit port of the 580B, immediately closed, and returned to the laboratory for analysis.

6.3 COLLECTION USING CHARCOAL TUBES

A technique very common in industrial hygiene-type analysis is to use a small charcoal tube as a collection device. An air sample is pulled through the charcoal tube at a known flow rate for a known period of time. This flow rate and time determine the total volume of air or total sample size. The organic vapors in the air are adsorbed on the charcoal in the tube. These vapors are then desorbed from the charcoal by adding a known volume of desorbing solvent, usually carbon disulfide. The organics end up in the carbon disulfide. The carbon disulfide is then injected into a gas chromatograph using Flame Ionization Detection. The individual organic vapors can then be identified and quantitated.

The usual charcoal tubes that are used for this type of work contain two sections. One section has approximately 100 milligrams of charcoal and a backup section has 50 milligrams. The backup section is analyzed separately from the main section to determine if there is organic vapor breakthrough in the main section. These particular size tubes have a recommended maximum flow in the neighborhood of 250 to 300 mL/min. The exit of the Model 580 is at 500 mL/min. The most advantageous way of using a smaller charcoal tube would be to split the exit stream and pass it through two parallel charcoal tubes. This would give approximately 250 mL through each tube. For analysis purposes, the charcoal of each tube is removed and combined using double the amount of solvent that would be required for a single tube.

The amount of total air that can be passed through charcoal tubes certainly depends on the concentration of organic vapor in the air. It also depends to some extent on the particular organic vapor. In general, a total sample through the smaller charcoal tube of 10 liters is a reasonably safe number to use. Since the flow is split exiting the 580B using the smaller charcoal tubes, only 250 ml/min is going through the tube. It would take 40 minutes to accumulate 10 liters passing through each of the tubes. There are charcoal tubes available in the marketplace containing 300 milligrams of charcoal in the front section and 150 milligrams of charcoal in the rear section. These tubes have correspondingly larger diameter and can accommodate higher volumetric throughputs. One of these tubes could be hooked to the exit of the 580B without doing the split. Conceivably since it contains 3 times the amount of charcoal, a safe operating total volumetric throughput would be approximately 30 liters. This would be a full hour's operating time on the Model 580B. Again, it must be stressed that the 580B when used in the particular form, is not being used as a personnel sampler to end up with the time weighted average concentration over an eight hour period. The intent here is to identify the high level organics observed on the 580B and to quantitate them following identification to determine the safe working area.

SECTION VII

COMMUNICATION

The 580B provides a serial (as opposed to parallel) communication port. There is also a communication cable provided for easy link up to a serial printer or RS-232 port of a computer. Logged data may be "dumped" (sent through the communication port) to a serial printer. Many of the 580B parameters may be set by a remote computer by using the serial port and the 580B communication software (the software is an option, part number 580A-9014).

Note: The serial port is not to be used in a hazardous location.

7.1 PRINTER

The 580B can be instructed to send all of its logged data through the serial port to a printer (or a dumb terminal). The 580B printer mode should be selected (see Section 2.7.4).The serial communication cable should then be plugged into the RS-232 port at the rear of the instrument and the other end of the cable plugged into the serial port of a printer. The 580B should finally be instructed to output to the printer (see section 2.7.1).

7.2 COMPUTER

The 580B provides capabilities for remote operation. Appendix A includes a detailed technical explanation of the 580B printer and computer interface protocol. The information in this appendix is sufficient for custom software to be developed for interfacing to the 580B. Thermo Environmental however has developed communication software which implements all of the available communication capabilities in a simple "menu driven" format. Remote communication may also be accomplished by using generic communication software package such as CrossTalk. Appendix A will be helpful if this route is taken.

NOTE: Generally, the RS-232 port on an IBM PC (or compatible) is a male connector. Since the communication cable provided with the 580B is also male, a "gender changer" (a DB-25 connector which converts from male to female) is needed.

7.3 COMMUNICATION SOFTWARE (OPTIONAL)

There is communication software available which will run on an IBM PC or compatible. The software provides the capability of obtaining or changing the 580B parameters (alarm setting, response factor, or operating mode to name a few). Logged data may be stored to disk or printed to a parallel printer. Concentrations may be read and displayed on the computer screen. There are a few operations which may not be accomplished remotely (for obvious reasons). The lamp may not be changed remotely. The lamp and pump may not be turned on from the computer either.

NOTE: The communication software will not work unless the 580B is attached via the communication cable.

7.3.1 HOW TO GUIDE FOR COMMUNICATION SOFTWARE

#1. The 580B must be turned on and connected to the computer's RS-232 port. The 580B must be in the computer mode (this is the default setting).

#2. The floppy disk should be inserted into the computer. Type 580B (this software was originally developed for the 580B) and then hit return. The introduction screen will appear.

#3. The software defaults to 2400 baud (as does the 580B). If some other baud rate is desired it must match the setting on the 580B.

#4. After selection of the baud rate press return. The main menu will appear.

NOTE: If the computer's screen goes blank and the main menu does not appear, then there is a problem with the communication link. Check to be sure that the communication cable is plugged into the RS-232 port and that the 580B is on.

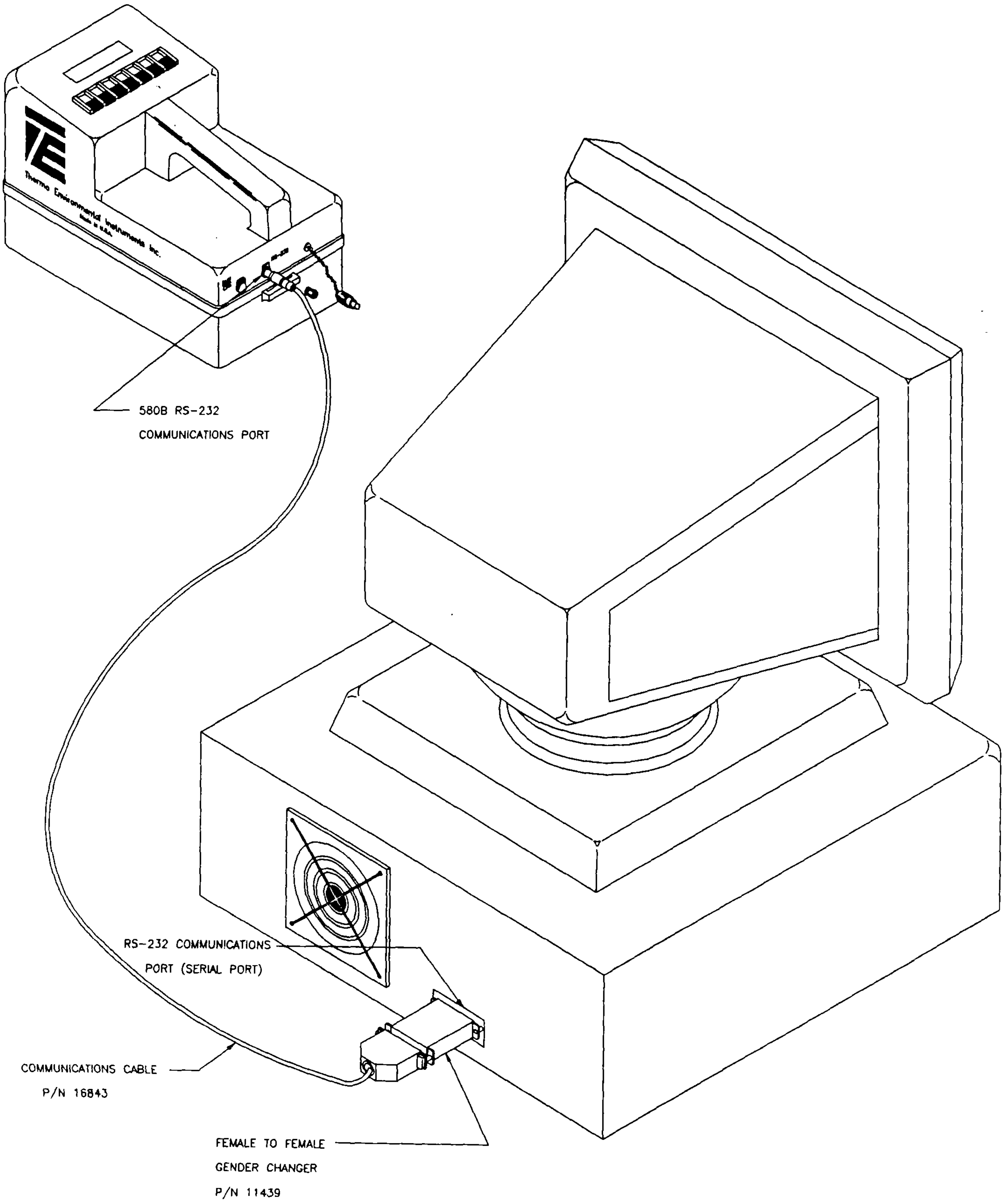


Figure 7.1
Serial Printer Communication

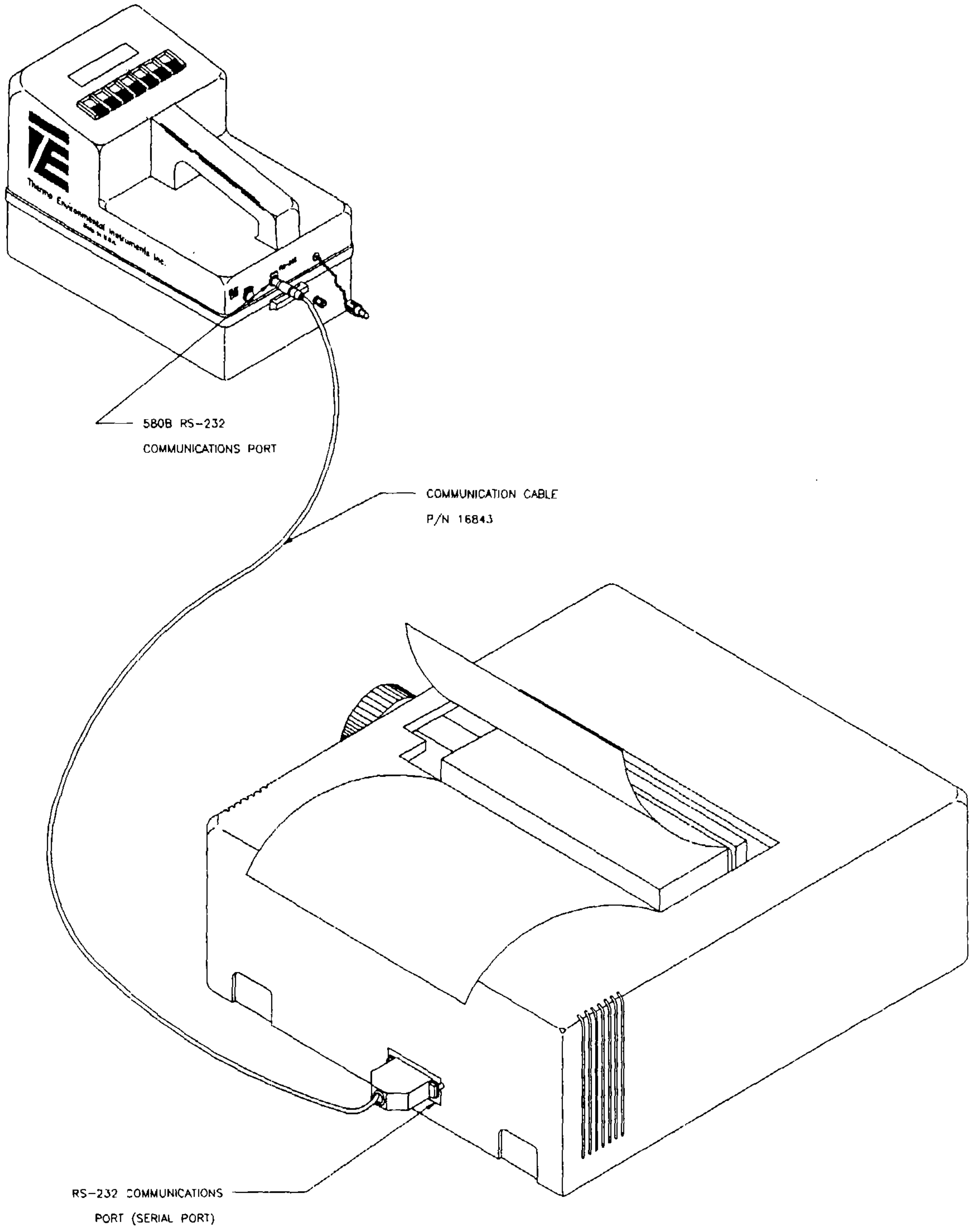


Figure 7.2
Computer Communication

SECTION VIII

FLOW CHART

There are two flow charts which illustrate the structure of the 580B software. The first is a "Quick Start-up" flow chart. Much of the detail is not included in this flow chart in order to diagram the basic structure of the software. The second flow chart includes extensive detail of each screen and the function of the seven buttons. These flow charts provide an easy method for determining how to get at each of the many facilities provided by the 580B.

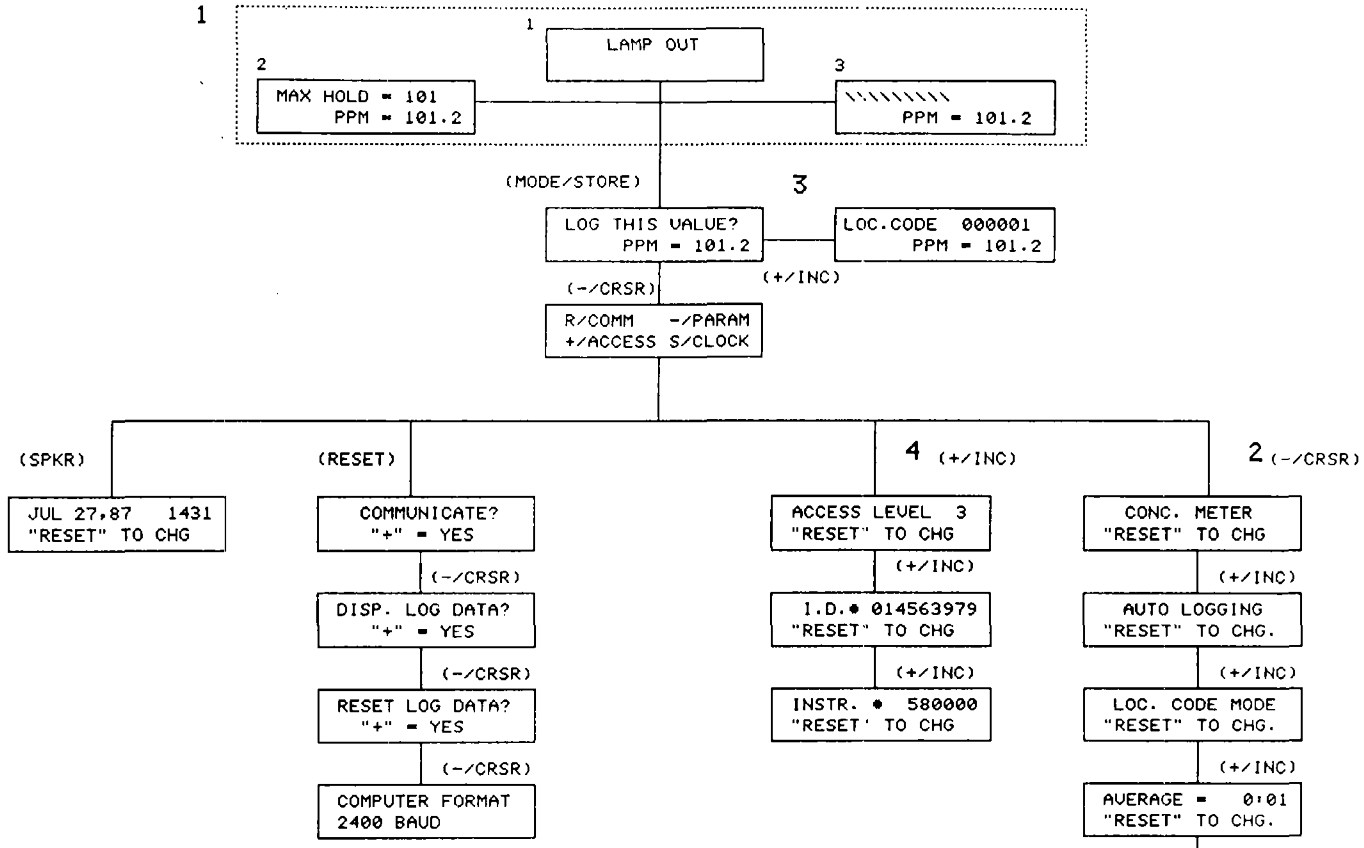
8.1 QUICK START-UP

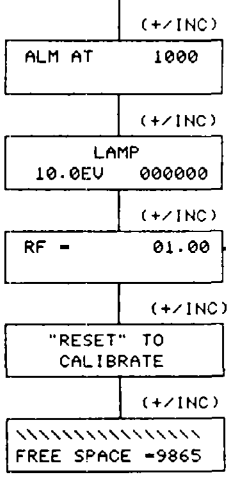
The Quick Start-up flow chart shows each of the top level screens. The screens are ordered according to the hierarchy of the 580B software. The particular button (which advanced the 580B to the next screen) is shown in parenthesis above each screen. This flow chart does not illustrate any of the associated screens or operations (see the detailed flow chart for more in depth information).

The Quick Start-up flow chart should be fully understood before moving on to the more detailed flow chart. The best way to learn each of the flow charts is to have the 580B with you and to follow along verifying each step.

8.2 DETAILED FLOW CHART

The detailed flow chart illustrates many of the lower level screens as well as the function of buttons. Screens are shown in rectangles with the text written inside. The buttons are shown in ellipses (actually a rather flattened ellipse) with the button identifier written inside. There are a few conventions which need to be explained. The button identifiers have been abbreviated. For example the +/INC button is simply denoted as +. When two buttons need to be pressed simultaneously each identifier is shown with a slash between them. For example RESET/+ indicates that the RESET and +/INC buttons should be pressed together. Arrows indicate the direction of flow from one screen to the next.





1 THE THREE SCREENS IN THE BOXED AREA REPRESENT THE RUN MODE SCREENS. IF THE LAMP IS NOT LIT THEN SCREEN ONE WILL BE ENABLED. ONCE THE LAMP IS LIT SCREEN TWO OR THREE WILL BE ENABLED DEPENDING ON THE THE CURRENT OPERATING MODE. IF THE CURRENT OPERATING MODE IS MAX HOLD THEN SCREEN TWO WILL BE ENABLED. OTHERWISE SCREEN THREE WILL BE ENABLED. THE OPERATING MODE IS SELECTED IN THE PARAMETERS SECTION.

2 THE 580B'S OPERATING PARAMETERS ARE ALL CONTAINED IN THIS SECTION. A BRIEF DESCRIPTION OF EACH PARAMETER IS GIVEN BELOW.

OPERATING MODE	: MAX HOLD OR NORMAL CONCENTRATION METER
AUTO LOGGING	: AUTOMATICALLY STORES (LOGS) DATA AT PRESET INTERVAL
AVERAGING INTERVAL	: FROM ONE SECOND UP TO FOUR MINUTES
ALARM SETTING	: ALARM WILL SOUND WHEN ALARM LEVEL IS EXCEEDED
LAMP SETTING	: SELECTS 10.0 OR 11.8 EV LAMP (SERIAL NUMBER ALSO)
RESPONSE FACTOR	: CORRELATES AN ORGANIC TO THE CALIBRATION GAS
CALIBRATION	: SECTION WHERE 580B IS CALIBRATED
FREE SPACE	: INDICATION OF AMOUNT OF ROOM LEFT FOR DATA STORAGE

3 THESE ARE THE SCREENS USED FOR LOGGING (STORING) DATA POINTS. AFTER ENTERING THE DESIRED LOCATION CODE, SIMPLY PRESSING THE MODE/STORE SWITCH WILL LOG THE VALUE (AS WELL AS A DATE AND TIME STAMP) AND RETURN OPERATION TO THE RUN MODE.

4 THE ACCESS (SECURITY) LEVEL IS SET IN THIS SECTION. ACCESS LEVEL THREE GIVES THE OPERATOR ACCESS TO ALL OF THE 580B'S FACILITIES. LOWER ACCESS LEVEL ZERO ARE PROGRESSIVELY MORE RESTRICTIVE. ACCESS LEVEL ZERO ONLY ALLOW READING AND LOGGING OF DATA.

Figure 8.1
Quick Flow Chart

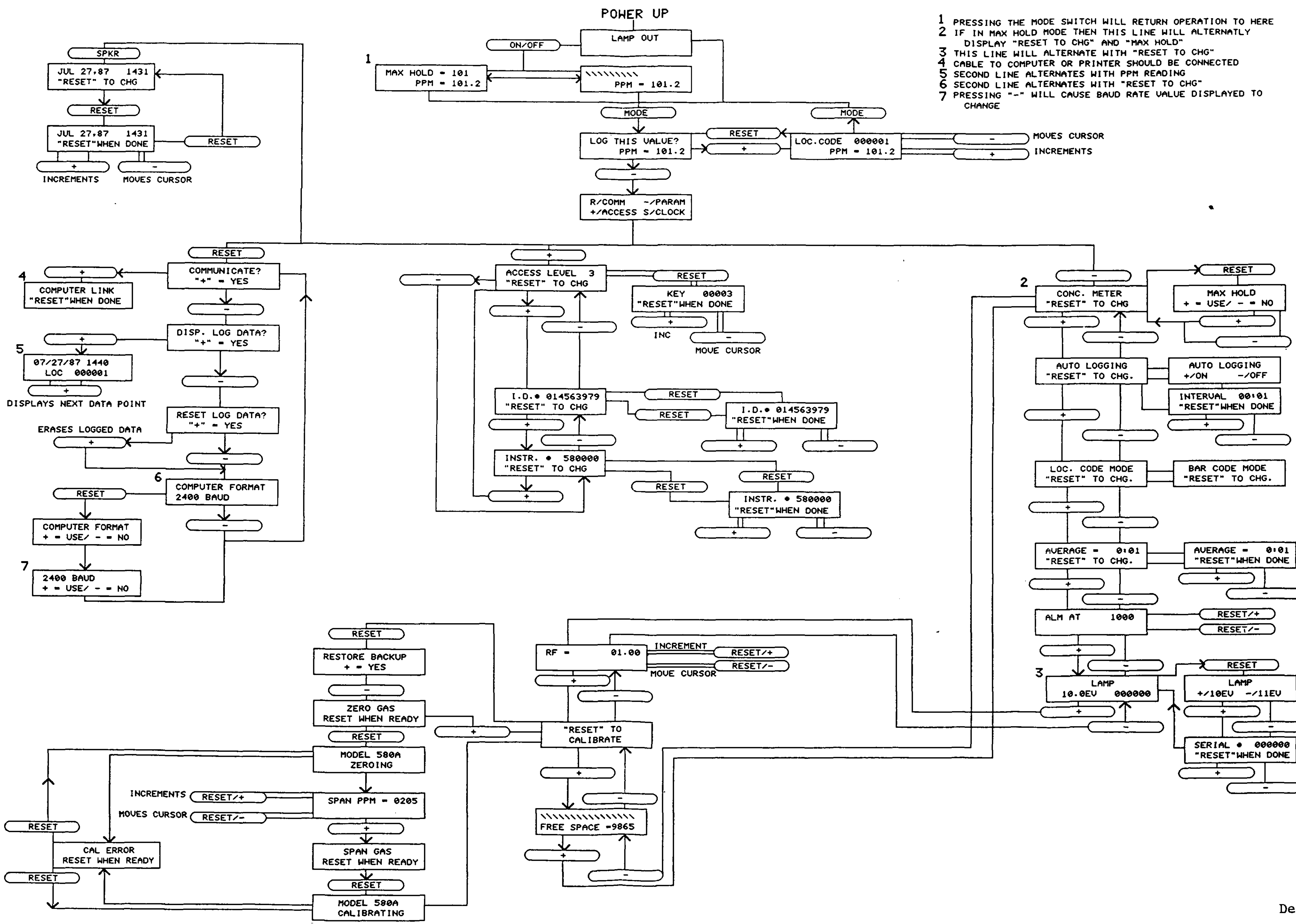


Figure 8.2
Detailed Flow Chart

APPENDIX A

COMMUNICATION

A.1 INTRODUCTION

The 580B is capable of communicating over an RS-232 link with any peripheral device which adheres to the communication protocol outlined in this document. The 580B will communicate with a peripheral device in one of two modes. While in the PRINTER mode the 580B responds to commands from its keypad and can be commanded to send characters out its RS-232 port to a peripheral device. In the COMPUTER mode the 580B responds to commands from a peripheral computer and can be commanded to send and receive data and to perform other tasks. Regardless of the mode used, the 580B sends and expects to receive data in the following format:

No Parity
1 Start Bit
8 Data Bits
1 Stop Bit
Baud Rate = 150, 300, 600, 1200, 2400, 4800 or 9600

The Baud Rate may be selected from the 580B keypad (see Section 2.7)

A.2 PRINTER MODE INTERFACE

In the PRINTER mode the 580B can be instructed to send its log data out the RS-232 port to a peripheral device such as a printer.

The 580B can be manually instructed from its keypad to output its log data. In this case the 580B sends all the log data points it has acquired thus far. The log data is saved in 580B memory and will NOT be automatically erased upon output. While in the PRINTER mode, the 580B log data file must be erased (reset) from the keypad. An example of a log data output is shown on page A-17. Notice that the 580B also sends header information which includes the following parameters: instrument number, user ID, and mode of operation. The date at the top of the header corresponds to the time when the first log data point was taken with the parameters set as shown in the header. If any of the parameters are changed and then new log data points are acquired, the 580B will send an updated header before it sends the new data points. It is also important to note that every log data point is time stamped to show when it was stored.

HARDWARE INTERFACE, PRINTER MODE

```
580B          PERIPHERAL

TxD  (B)__________)RxD
CTS  (E)(__________DTR (or "printer ready")
GND  (A)___________GND
```

The connections shown above are required before the 580B can successfully send its log data to the peripheral. An example of a cable used for PRINTER MODE communication is shown below:

SAMPLE CABLE, 580B TO HP THINKJET PRINTER

```
580B          PRINTER

TxD (B)________)RxD (3)
CTS (E)(________DTR (20)
GND (A)_________GND (1)
GND (F)_________GND (7)
```

Thinkjet connector = TRW/CINCH DB-25P plug connector

Please remember that the 580B must be placed into the PRINTER mode prior to output of log data to a printer. This is done from the 580B keypad.

HARDWARE HANDSHAKING, PRINTER MODE

The 580B will send log data out the port to a peripheral device as long as its CTS line is asserted (+V). If the peripheral has temporarily fallen behind, and consequently clears its DTR line (-V), the 580B will stop transmitting data. It will resume transmitting as soon as the peripheral reasserts (+V) its DTR line.

A.3 COMPUTER MODE INTERFACE

In the COMPUTER mode the 580B will respond to commands sent by a peripheral computer. The 580B will respond to 3 types of commands; DO, GET, and SET commands..

An example of a DO command is "DO RESET LOG (ret)" in which the 580B is instructed to reset its log which, in effect, clears all previously stored log data points.

A GET command such as "GET ALARM (ret)" allows the peripheral to change a specified parameter in the 580B to a value provided by the peripheral.

A combination of DO, SET, and GET commands allow the operator at the peripheral to perform a variety of functions needed to prepare a 580B for acquiring data.

The 580B can also be operated under "computer control". For example, the 580B can be commanded to acquire readings at specified intervals and then store the readings in a log data file.

The 580B can subsequently be commanded to send its log data to a printer, a file or the screen of the peripheral computer. This can all be accomplished through commands issued by the peripheral computer. So, effectively the 580B is under "computer control".

HARDWARE INTERFACE, COMPUTER MODE

```
580B               COMPUTER

TxD (B)___________)RxD
RxD (C)(___________TxD
CTS (E)(___________DTR
                 !___DSR
GND (A)____________GND

                  ___CTS
                 !___RTS
```

The connections shown above are required before the peripheral computer can successfully communicate with the 580B. In addition, the 580B must be placed into COMPUTER mode. This is done from the 580B keypad.

An example of a cable used for COMPUTER MODE communication is shown below:

SAMPLE CABLE, 580B TO IBM PC

```
580B               COMPUTER

TxD (B)________)RxD  (3)
RxD (C)(________TxD  (2)
CTS (E)(________DTR (20)
            !___DSR  (6)

GND (A)_________GND  (7)
            !___GND  (1)

             ___CTS  (5)
            !___RTS  (4)
```

If the peripheral's DTR line is asserted (+V), the 580B will look for and then respond to peripheral commands. As long as DTR remains high, the 580B will NOT perform functions such as counting, updating the display, storing log data, etc. If DTR is asserted, the 580B will display the following message:

"COMPUTER LINK"
"WAITING FOR COMM"

The 580B must be allowed 100ms between the time the peripheral asserts DTR and the time it sends the 580B its first message. If the 580B is busy communicating the display will read:

When DTR is low (-V), the 580B will return to its normal mode of operation where it counts, updates the display, etc. and will NOT respond to peripheral commands.

XON/XOFF HANDSHAKING, COMPUTER MODE

If the 580B is transmitting log data and detects that an XOFF has been received, it will stop transmitting. The 580B will not resume transmission until the peripheral device sends XON. The 580B will respond to XON and XOFF characters only if it is NOT communicating with the computer (i.e., if 580B CTS is NOT asserted).

It is important to note that if the 580B receives an XOFF it will stop transmitting and will simply wait for the peripheral to send XON, it will not acquire data, update the display or perform other functions. The 580B is essentially "locked up" until it receives XON. For this reason, it would be good programming practice to send out an XON to the 580B prior to 580B/peripheral communication and afterwards also. Consequently, if an XOFF character is sent to the 580B inadvertently, the 580B will not be locked up indefinitely.

PERIPHERAL/580B COMMAND MESSAGES

A command message is a string of upper-case ASCII characters terminated by an ASCII carriage return. The carriage return may immediately follow the command or a space may separate the command and the carriage return as shown in the example below. The command messages which the 580B will accept from the peripheral are listed in TABLE A.1. The 580B will accept the messages as shown in TABLE 1 or the command portion of the message can be abbreviated as follows:

"S R F 01.00 (ret)" instead of
"SET RESPONSE FACTOR 01.00 (ret)"

Please note that the abbreviation must contain the first letter of each and every word of the command. There are some additional guidelines for abbreviating the SET OPERATING MODE commands.

If the abbreviated version of a command is sent, an ASCII blank must separate each letter of the command and must separate the command from the data. Note that the command message will contain data only if a SET command is being sent.

If the spelled-out version of a command is sent, an ASCII blank must separate each word of the command and must separate the command from the data.

Every SET command message contains a data value. The data sent as part of a SET command must conform to the formats described in TABLE A.1. It is important to note that the 580B does NOT perform error-checking on data sent as part of a SET command.

It is up to the user to insure that the data value is "reasonable" and formatted as shown in TABLE A.1.

The following are examples of valid command messages:

"SET ACCESS LEVEL 3 (ret)"
or "S A L 3 (ret)"

"SET REAL TIME 02/15/86 1723 (ret)"
or "S R T 02/15/86 1723 (ret)"

580B/PERIPHERAL RESPONSE MESSAGES

A response message is a string of upper-case ASCII characters terminated by an ASCII carriage return. The response messages which ~~the 580B will send~~ to the peripheral are listed in TABLE A.1. The messages which the 580B sends in response to a GET command contain data formatted as shown. The notes which follow TABLE A.1 describe the GET command response messages in more detail.

SOFTWARE HANDSHAKING, COMPUTER MODE

Every command message must be preceded by the "WAKE UP/PROCEED" sequence. This sequence begins when the peripheral sends a WAKE UP ("?") character to the 580B. The 580B must respond with a PROCEED ("!") character before the computer can send a command message. In the discussion to follow, the WAKE UP/PROCEED sequence will be referred to as (WAKE UP/PROCEED).

The peripheral sends command messages to the 580B an entire line at a time. When the 580B receives the command line it will echo the line back to the peripheral. The peripheral will examine the echo to determine if the 580B received the command correctly. If the echo was correct, the peripheral will signal the 580B with the PROCEED character. The 580B will then perform the task specified by the command message. In the discussion ahead, the command message and echo sequence will be referred to as (COMMAND/ECHO/PROCEED).

The software handshaking sequences for each of the 3 types of commands are given below:

DO COMMANDS

The handshake sequence for a DO command is as follows:

1. (WAKE UP/PROCEED)
2. (COMMANDS/ECHO/PROCEED)
3. 580B performs task
4. 580B sends PROCEED or ERR

If the 580B was able to successfully complete the task it will send a PROCEED character in step 4, otherwise it will send the error message ("ERR").

GET COMMANDS

The handshake sequence below applies to all of the GET commands with the exception of GET LOG DATA and GET CONTINUED LOG:

1. (WAKE UP/PROCEED)
2. (COMMAND/ECHO/PROCEED)
3. 580B sends data message
4. Peripheral echoes data message
5. 580B sends PROCEED or ERR

The message sent by the 580B in response to a GET command are shown in TABLE 1. When the peripheral receives the message containing the data it echoes the entire message back to the 580B. If the echo is correct the 580B will send the PROCEED character so that the peripheral knows it received the data correctly. If the echo is not correct, the 580B will send "ERR".

The GET LOG DATA and GET CONTINUED LOG commands differ from the other GET commands in that the 580B sends an indefinite number of data values. The handshake sequence for these commands is as follows:

1. (WAKE UP/PROCEED)
2. (COMMAND/ECHO/PROCEED)
3. 580B sends a log data point message
4. If message = "EOT" (end of transmission) then DONE, otherwise go on to step 5.
5. Peripheral echoes entire message
6. 580B sends PROCEED or ERR
7. Peripheral sends PROCEED
8. Go to step 3

In step 4, the 580B sends "EOT" if it has sent all the log data points available. If some time later the peripheral sends "GET CONTINUED LOG (ret)" the 580B will send any additional data points it may have acquired since the GET LOG DATA command. In step 6, the 580B will send PROCEED if the peripheral echoed the message correctly in step 5. The 580B will also increment its data buffer pointer. If however, the peripheral did <u>NOT</u> correctly echo the message in step 5, the 580B will send "ERR" in step 6 and will <u>NOT</u> increment its data buffer pointer. This means that the next time through step 3, the 580B will send the same data point again. In either case, the peripheral must send a PROCEED in step 7.

SET COMMANDS

The handshaking sequence for a SET command is as follows:

1. (WAKE UP/PROCEED)
2. (COMMAND/ECHO/PROCEED)
3. 580B sets parameter to value
4. 580B sends PROCEED or ERR

In step 3 the 580B sets the parameter specified by the command to the value provided by the peripheral in the command message. The data value sent in the SET command message must be formatted as shown in TABLE 1. If the 580B is able to successfully set the parameter it will send the PROCEED character, otherwise it will send "ERR".

NOTE: The flowcharts shown in Figures A.1 - A.4 are included to further explain the software handshaking sequences required for successful communication between the peripheral and the 580B.

TABLE A.1
MESSAGE FORMATS

PERIPHERAL COMMAND	580B RESPONSE
DO COMMANDS	
DO END COMMUNICATIONS (ret)	! (ret)
DO RESET LOG (ret)	! (ret)
GET COMMANDS	
GET ACCESS LEVEL (ret)	ACCESS LEVEL I (ret)
GET ALARM SETTING (ret)	ALARM SETTING IIII (ret)
GET CONTINUED LOG (ret)	(see notes which follow)
GET INSTRUMENT NUMBER (ret)	INSTRUMENT # IIIIII (ret)
GET LOCATION CODE (ret)	LOCATION CODE IIIIII (ret)
GET LOG DATA (ret)	(see notes which follow)
GET OPERATING MODE (ret)	OPERATING MODE: ASCII (50) (ret)
GET MAX READING (ret)	LAST MAX VALUE IIII ASCII (8) (ret)
GET RATEMETER READING (ret)	LAST CONC VALUE IIII ASCII (8) (ret)
GET REAL TIME (ret)	REAL TIME CLOCK II/II/II IIII (ret)
GET USER ID (ret)	USER I.D. # IIIIIIIII (ret)
GET RESPONSE FACTOR (ret)	RESPONSE FACTOR II.II (ret)
GET SPAN CONCENTRATION (ret)	SPAN CONCENTRATION IIII (ret)
GET VERSION NUMBER (ret)	580B VERSION 1.0 (ret)
GET LOGGING INTERVAL (ret)	I:II (ret)
SET COMMANDS	
SET ACCESS LEVEL I (ret)	! (ret)
SET ALARM SETTING IIII (ret)	! (ret)
SET INSTRUMENT NUMBER IIIIII (ret)	! (ret)
SET LOCATION CODE IIIIII (ret)	! (ret)
SET OPERATING MODE ASCII (50) (ret)	! (ret)
SET REAL TIME II/II/II/ IIII (ret)	! (ret)
SET USER ID IIIIIIIII (ret)	! (ret)
SET RESPONSE FACTOR II.II (ret)	! (ret)
SET SPAN CONCENTRATION IIII (ret)	! (ret)
SET LOGGING INTERVAL I:II (ret)	! (ret)

NOTES ON TABLE A.1

The peripheral will receive data back from the 580B in response to a GET command only. The 580B response to a DO or SET command is the PROCEED ("!") character. This is because the 580B does not actually return data but signals the peripheral with the PROCEED character if it was able to perform the task requested. If for some reason the 580B is unable to perform the task it will send an error message "ERR" rather than PROCEED.

The data values sent by the peripheral as part of a SET command message and the data received by the peripheral in response to a GET command must be formatted as shown in TABLE A.1.

The data format codes used in TABLE 1 are described below:

I	a single digit
III...II	an integer "string", the number of I's shown indicates the length of the string. Note: the "string" MUST be the length specified, use leading zeros if necessary.
ASCII (n)	an ASCII string with a maximum of n characters

Several of the command messages listed in TABLE 1 require additional explanation. These comments are listed according to the command name:

DO RESET LOG

This command instructs the 580B to clear its log data file. All log data values acquired previously will be erased.

GET CONTINUED LOG

This command instructs the 580B to send any log data points acquired since the last GET LOG DATA command. The format of the 580B response will be the same as the response to the GET LOG DATA command.

GET LOG DATA

This command instructs the 580B to send all of its log data points. The log data file is saved in 580B memory and is NOT automatically erased upon output. The log data file may be erased (reset) with the DO RESET LOG command.

GET OPERATING MODE

The 580B responds to a GET OPERATING MODE command by sending a string "MODE: ", followed by an ASCII string which describes the current 580B mode of operation. The 580B responses to the

GET OPERATING MODE command are listed below:

OPERATING MODE: CONCENTRATION METER NORMAL
OPERATING MODE: CONCENTRATION METER MAX HOLD

GET MAX READING

The 580B responds to a GET MAX READING command by sending the max value as shown in TABLE A.1. After the 580B sends the max reading it resets the max value to 0.

GET REAL TIME

The 580B will return its real time as an ASCII string in the following format: "05/29/86 1422"

SET ACCESS LEVEL

The access level must be an integer in the range 0 to 3

SET INSTRUMENT NUMBER

The instrument number is a string of 6 integers. If the instrument number = 2 then the number must be represented as 000002 (i.e. leading zeros must fill in excess spaces). An example of a valid SET INSTRUMENT NUMBER command is "SET INSTRUMENT NUMBER 000002 (ret)".

SET LOCATION CODE

The location code is a string of 6 integers. If the location code = 234 then the correct SET LOCATION CODE command is "SET LOCATION CODE 000234 (ret)". (Leading zeros must fill excess spaces.)

SET OPERATING MODE

As shown in TABLE A.1, the command SET OPERATING MODE must be followed by an ASCII string which describes the mode. The list of valid SET OPERATING MODE commands along with valid abbreviations are listed below:

SET OPERATING MODE CONCENTRATION (ret)
S O M C (ret)

SET OPERATING MODE MAX HOLD (ret)
S O M M H (ret)

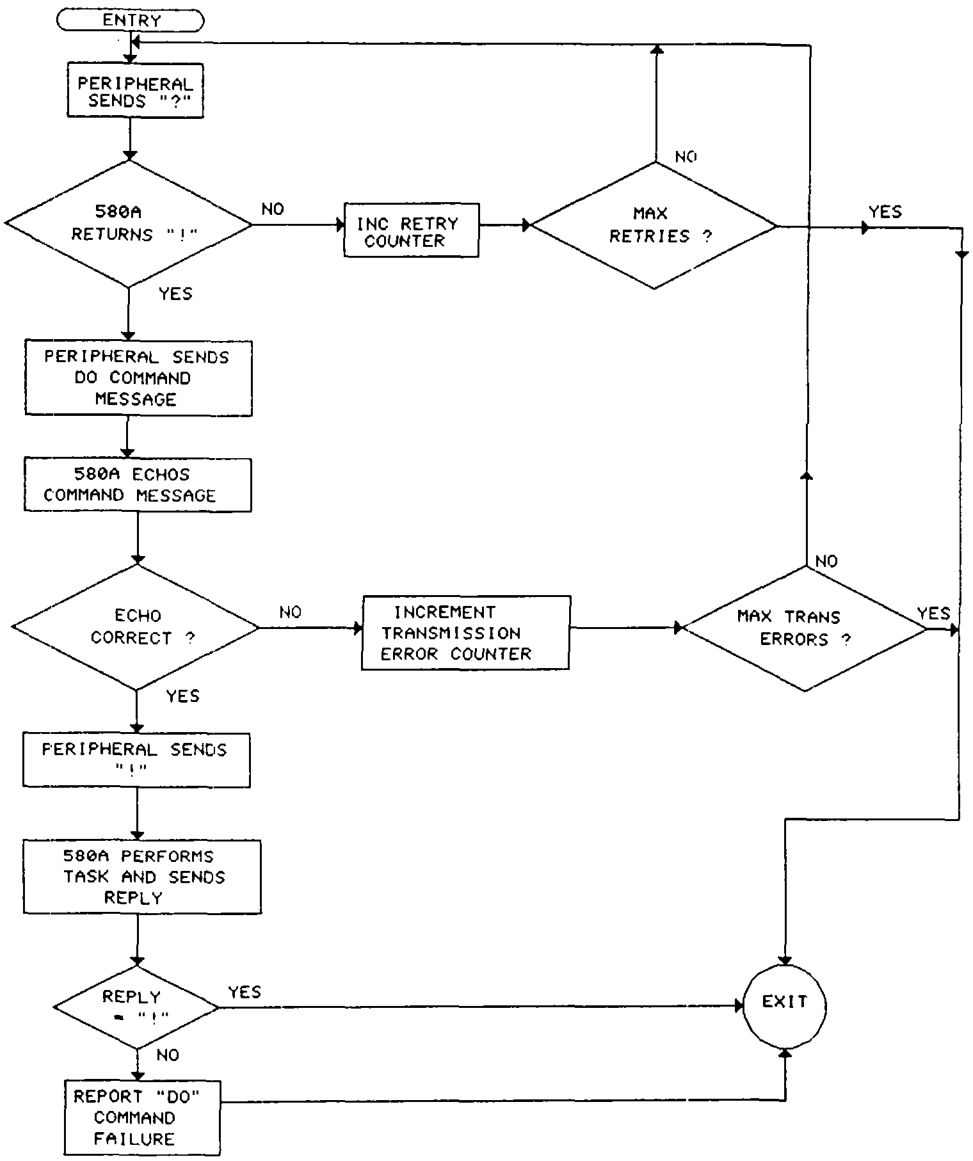


Figure A.1
Software Handshake
Do Commands

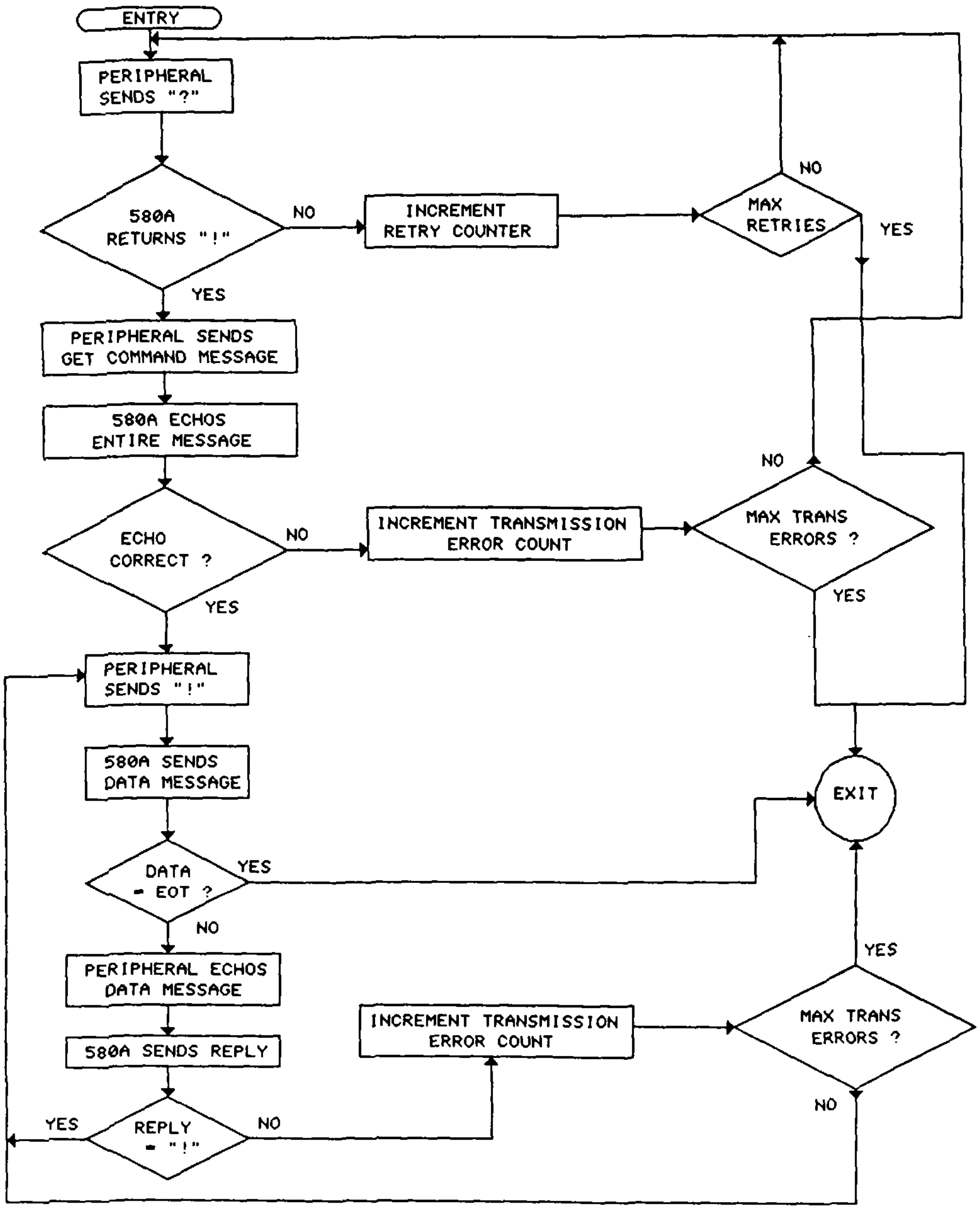


Figure A.2
Software Handshake
Get Log Data, Get Continue Log Command

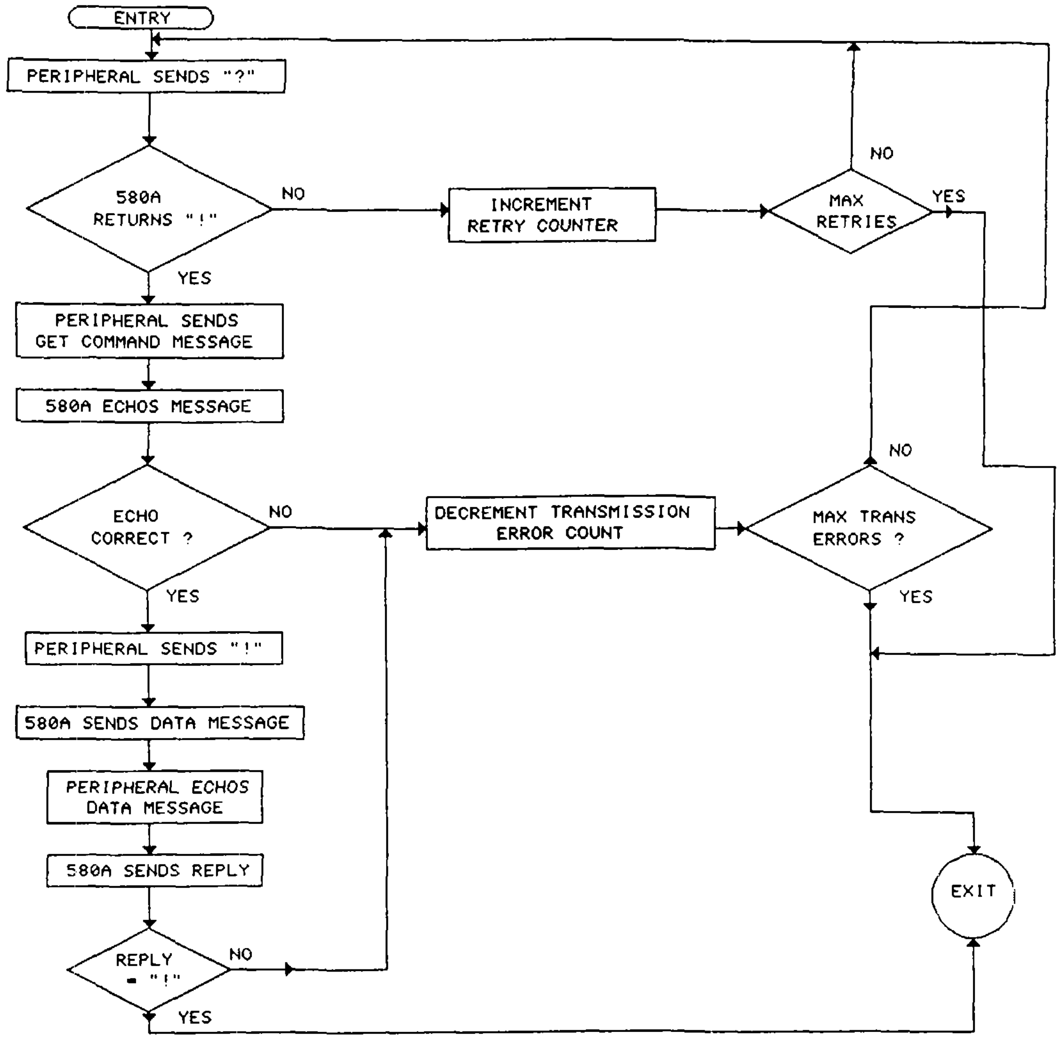


Figure A.3
Software Handshake
Get Command
(Except Get Log Data, Get Continue Log)

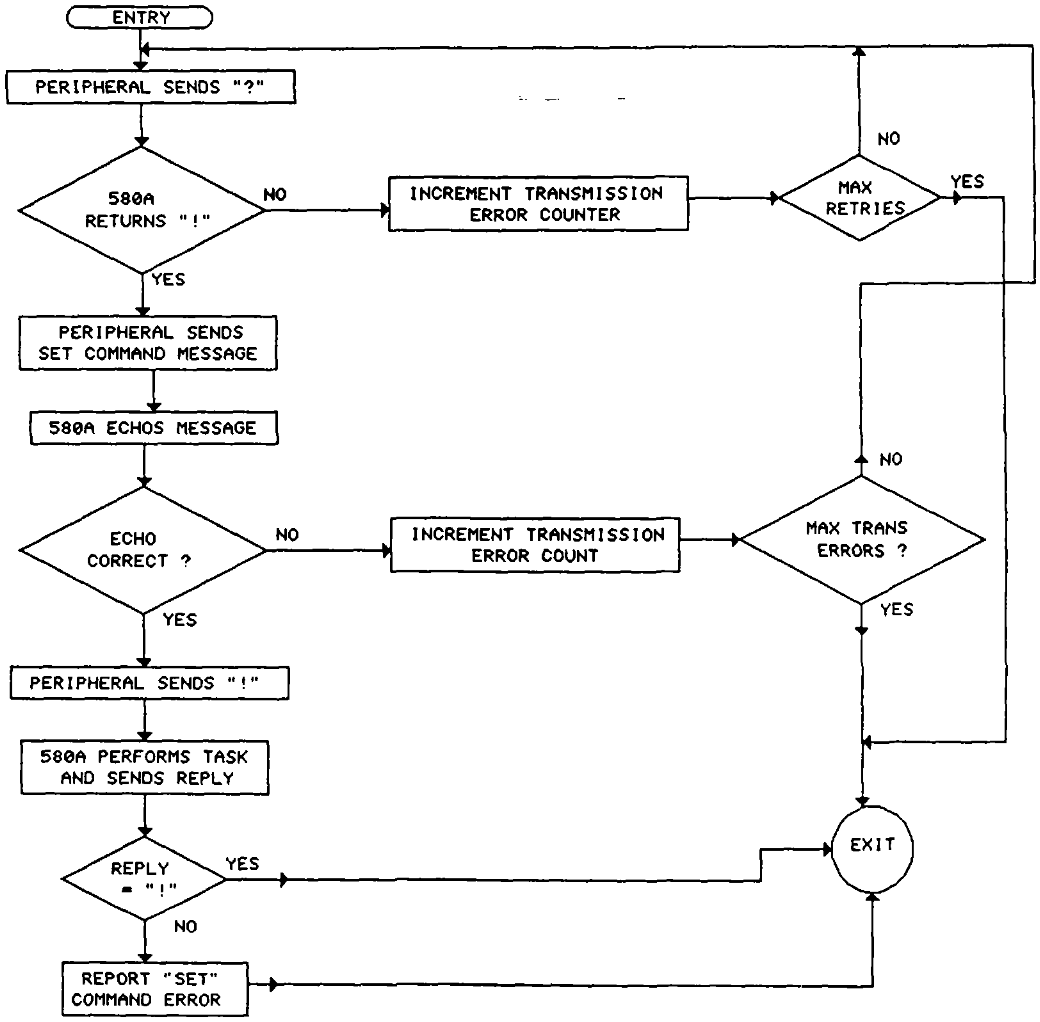


Figure A.4
Software Handshake
Set Commands

SET REAL TIME

The format for setting the real time is as follows:

```
II/II/II IIII
 .  .  .  . .
 .  .  .  . .........minutes (max=59)
 .  .  .  ...........hours (max=23)
 .  .  ..............year
 .  .................day
 ....................month
```

For example: SET REAL TIME 02/15/86 1723 (ret)
This instructs the 580B to set its real time clock to February 15, 1986 5:23 p.m.

SET USER ID

The user ID is a string of 9 integers. To set user ID = 66, use the following command "SET USER ID 000000066 (ret)" (leading zeros must fill in excess spaces).

```
 580B   VER. 1.1
 07/11/88 1508
 INSTRUMENT #     580000
 USER I.D. #      014569373
 OPERATING MODE: CONC. METER, MAX HOLD

                  LOC.         PPM     STATUS
07/11/88 1508    000000       0012
07/11/88 1508    000001       0047
07/11/88 1508    000002       0000
07/11/88 1508    000003       0050
07/11/88 1508    000004       0021
07/11/88 1508    000005       0010
07/11/88 1509    000006       0061
07/11/88 1509    000007       0046
07/11/88 1509    000008       0004
07/11/88 1509    000009       0104    ALARM
07/11/88 1509    000010       0076

 07/11/88 1509
 INSTRUMENT #     580000
 USER I.D. #      014569373
 OPERATING MODE: CONC. METER

                  LOC.         PPM     STATUS
07/11/88 1509    000011       0000
07/11/88 1509    000012       0064
07/11/88 1509    000013       0052
07/11/88 1509    000014       0001
07/11/88 1509    000015       0007
07/11/88 1509    000016       0101    ALARM
```

Figure A.5
Data Log Output

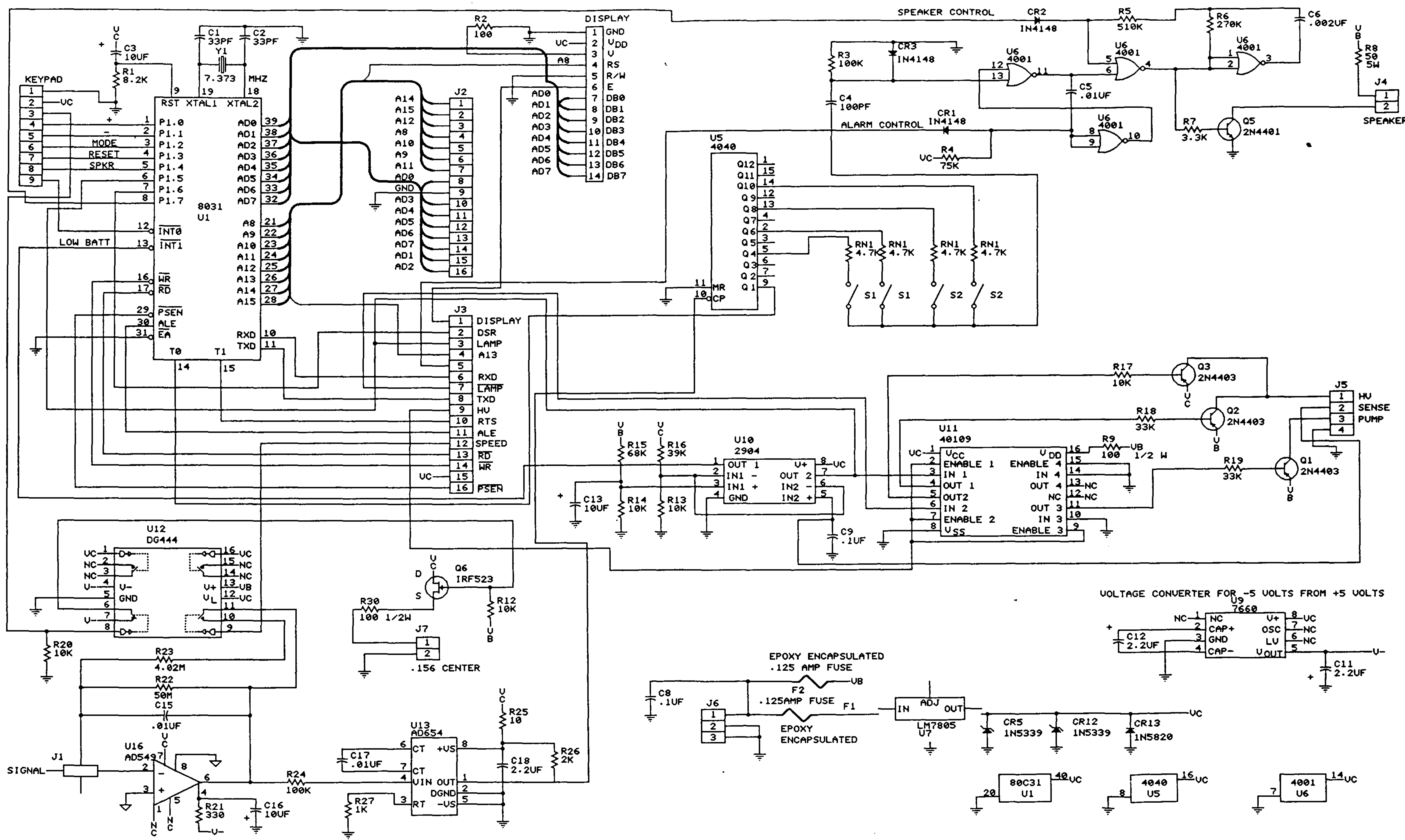


Figure B-1
Processor Board Schematic

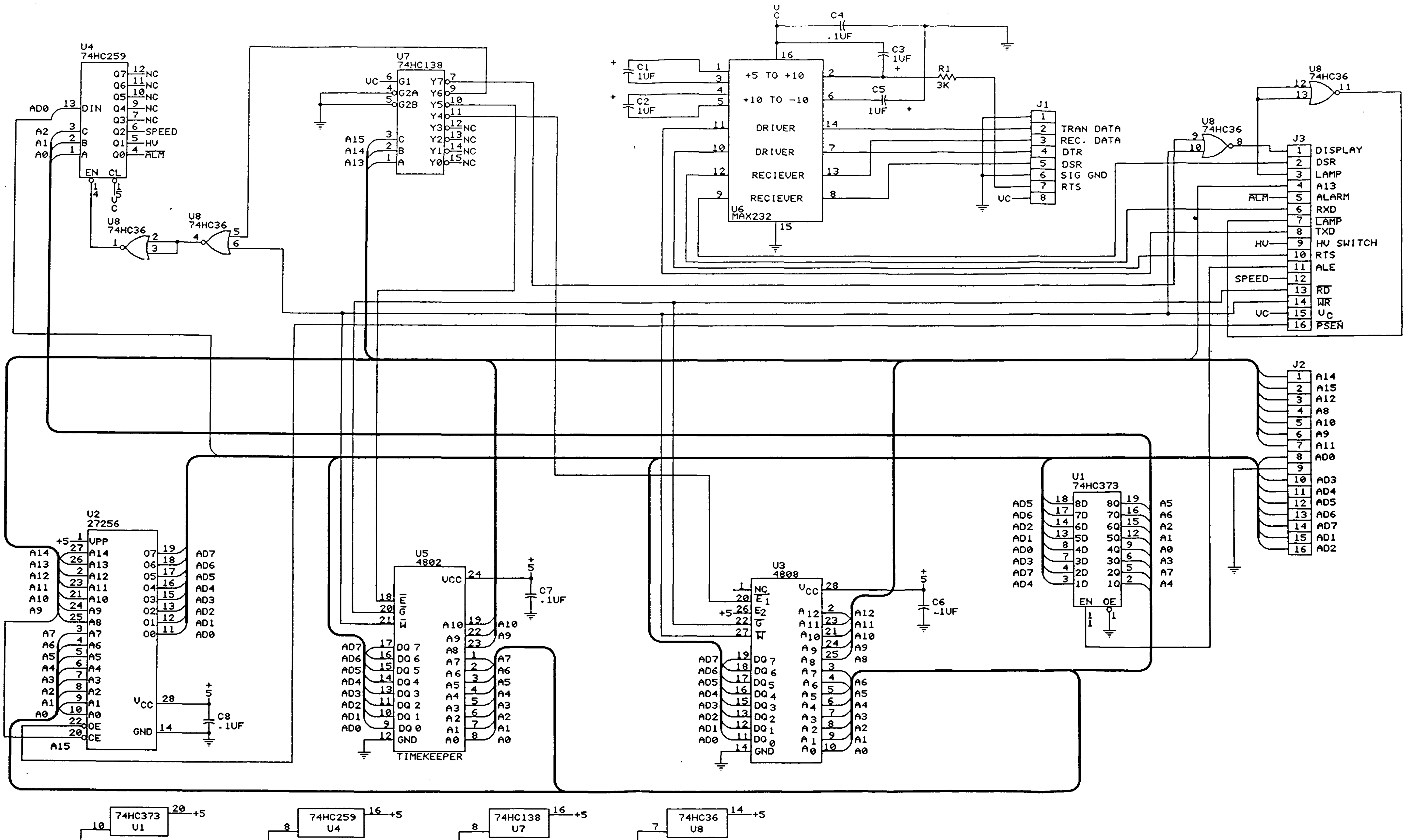
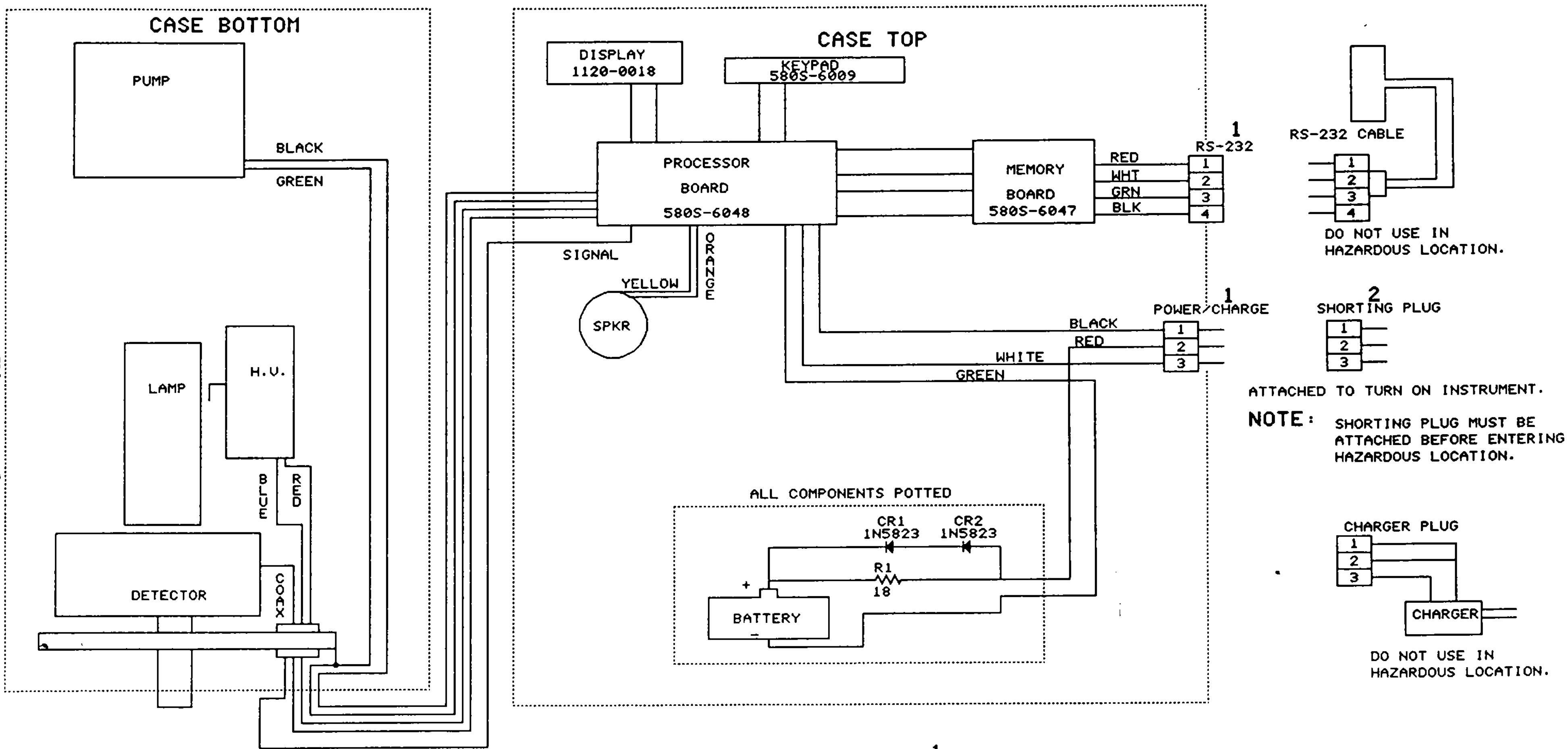


Figure B.2
Memory Board Schematic



1 CONNECTORS MOUNTED ON REAR OF CASE TOP.

2 SHORTING PLUG IS TETHERED TO PREVENT ITS LOSS.

Figure C.1
Block Diagram

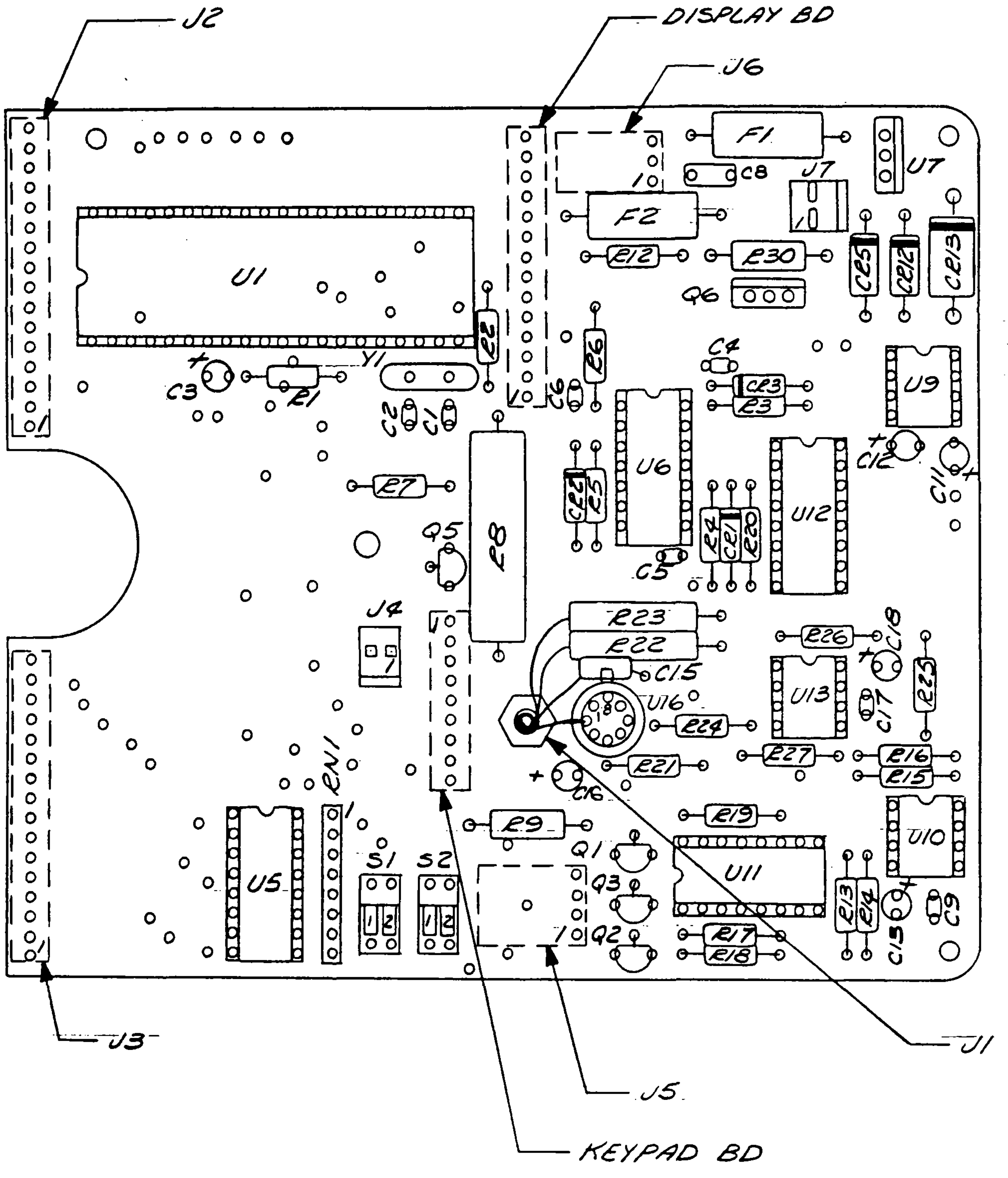


Figure D.1
Processor Board Loading Drawing

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	11695	U1	80C31 8 BIT MICROCONTROLLER
1	11696	U5	4040 BINARY COUNTER
1	11697	U6	4001 NOR GATE
1	11126	U7	LM7805 5 VOLT REGULATOR
1	11694	U9	7660 VOLTAGE CONVERTER
1	11716	U10	LM2904 DUAL OP AMP
1	11717	U11	CD40109B QUAD LEVEL SHIFTER
1	11723	U12	DG-444 ANALOG SWITCH
1	9296	U13	AD654 V/F
1	11097	U16	AD515 ELECTROMETER
2	10391	C1,2	CAPACITOR, 33PF
3	10376	C3,13, 16	CAPACITOR, 10UF
1	5609	C4	MONOLITHIC CAPACITOR, 100PF
2	5605	C5,15	MONOLITHIC CAPACITOR, .01UF
1	10399	C6	MONOLITHIC CAPACITOR, .002UF
2	10372	C8,9	MONOLITHIC CAPACITOR, .1UF
3	10390	C11,12, 18	CAPACITOR, 2.2UF
1	9333	C17	MONOLITHIC CAPACITOR, .01UF
1	10790	R1	RESISTOR, 8.2K
1	10847	R2	RESISTOR, 100, 1/4W
2	10862	R3,24	RESISTOR, 100K
1	10928	R4	RESISTOR, 75K
1	10929	R5	RESISTOR, 510K

BILL OF MATERIALS 580S-6048 — THERMO ENVIRONMENTAL INSTRUMENTS

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	10930	R6	RESISTOR, 270K
1	5986	R7	RESISTOR, 3.3K
1	10939	R8	RESISTOR, 50, 5W
2	10704	R9,30	RESISTOR, 100, 1/2W
5	10864	R12-14 17,20	RESISTOR, 10K
1	10938	R15	RESISTOR, 68K
1	6025	R16	RESISTOR, 39K
2	2219	R18,19	RESISTOR, 33K
1	10786	R21	RESISTOR, 330
	6150	R22	RESISTOR, 50M
1	6116	R23	RESISTOR, 4.02M
1	10846	R25	RESISTOR, 10
1	10936	R26	RESISTOR, 2K
1	10863	R27	RESISTOR, 1K
1	11641	RN1	NETWORK, 4.7K X 6
3	11807	CR1,2, 3	IN4148
2	11829	CR5,12	IN5339
1	11850	CR13	IN5820
1	10557	Y1	7.373 MHZ
1	10446	J1	RADIAL SMC
1	11398	J4	2 PIN AMP, .100 CENTER
1	11418	J5	4 PIN MTE
1	11419	J6	3 PIN MTE

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	11405	J7	2 PIN AMP .156 CENTER
2	580S-6040	F1,2	.125 AMP FUSE ASSEMBLY
2	12138	S1,2	SPST SWITCH, DUAL
3	11762	Q1-3	2N4403
1	11759	Q5	2N4401
1	11773	Q6	IRF523
1	580S-2057		PCB BLANK

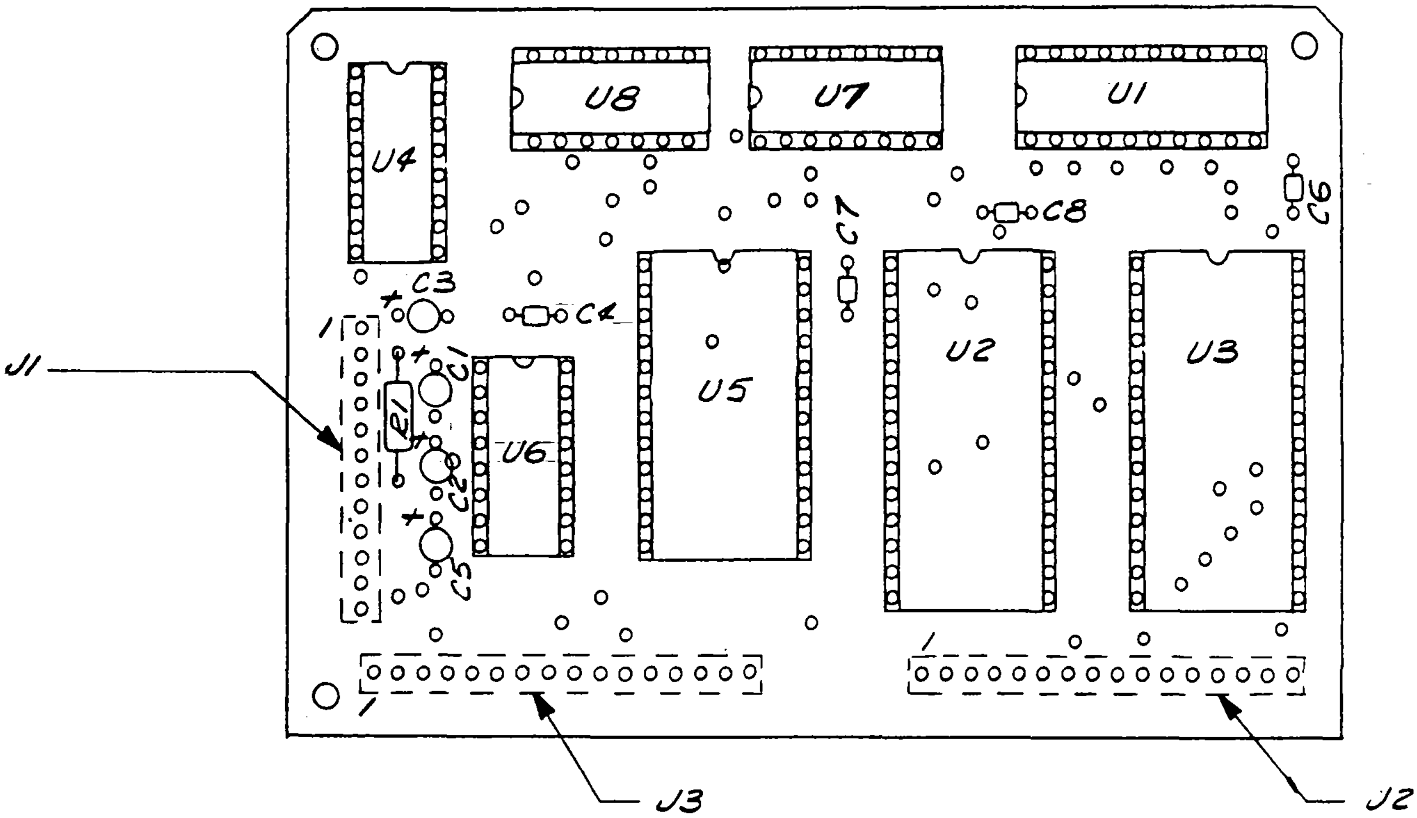


Figure D.2
Memory Board Loading Drawing

BILL OF MATERIALS   THERMO ENVIRONMENTAL INSTRUMENTS
580S-6047

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	11689	U1	74HC373
1	11728	U2	27C256 8K EPROM
1	11687	U3	48Z08 8K X 8 BATTERY BACKED RAM
1	11688	U4	74HC259 OUTPUT PORT
1	11691	U5	48T02 2K X 8 TIMEKEEPER RAM
1	11685	U6	MAX232 RS-232 CHIP
1	11151	U7	74HC138
1	11699	U8	74HC36
4	10378	C1-3, 5	1UF CAPACITOR
4	10372	C4,6, 7,8	MONOLITHIC CAPACITOR, .1UF
1	10789	R1	RESISTOR, 3K
1	11374	X7	28 PIN SOCKET
1	580S-2056 (16839)		PCB BLANK

ITEM	PART NO.	DESCRIPTION	QTY
17		M3 X .5 METRIC INSERT	1
16	5822	6-32 X 5/8 LG BIND HD SC	2
15	12088	8-32 X 1" LG FLAT HD SC	3
14	5856	6-32 X 1/2" LG PAN. HD SC	2
13	7534	NYLON WASHER	1
12	5815	4-40 X 5/16" LG. BND. HD. SC.	1
11	5862	6-32 X 1/4" LG FLT HD MCH SC.	2
10	5808-6027	P.C. BD SET UL	1
9	0370-0007	KEYPAD	1
8	5808-6007	SHORTING PLUG (11432)	1
7	5808-2003	DUST COVER	1
6	5808-6029	RS-232 HARNESS ASSY.	1
5	5805-6014	POWER HARNESS (13558)	1
4	5806-0008	BATTERY HOLDER	1
3	5803-6039	BATTERY ASSY.	1
2	5804-6015	SPEAKER ASSY (13675)	1
1	5808-4002	CASE TOP	1

BILL OF MAT'L

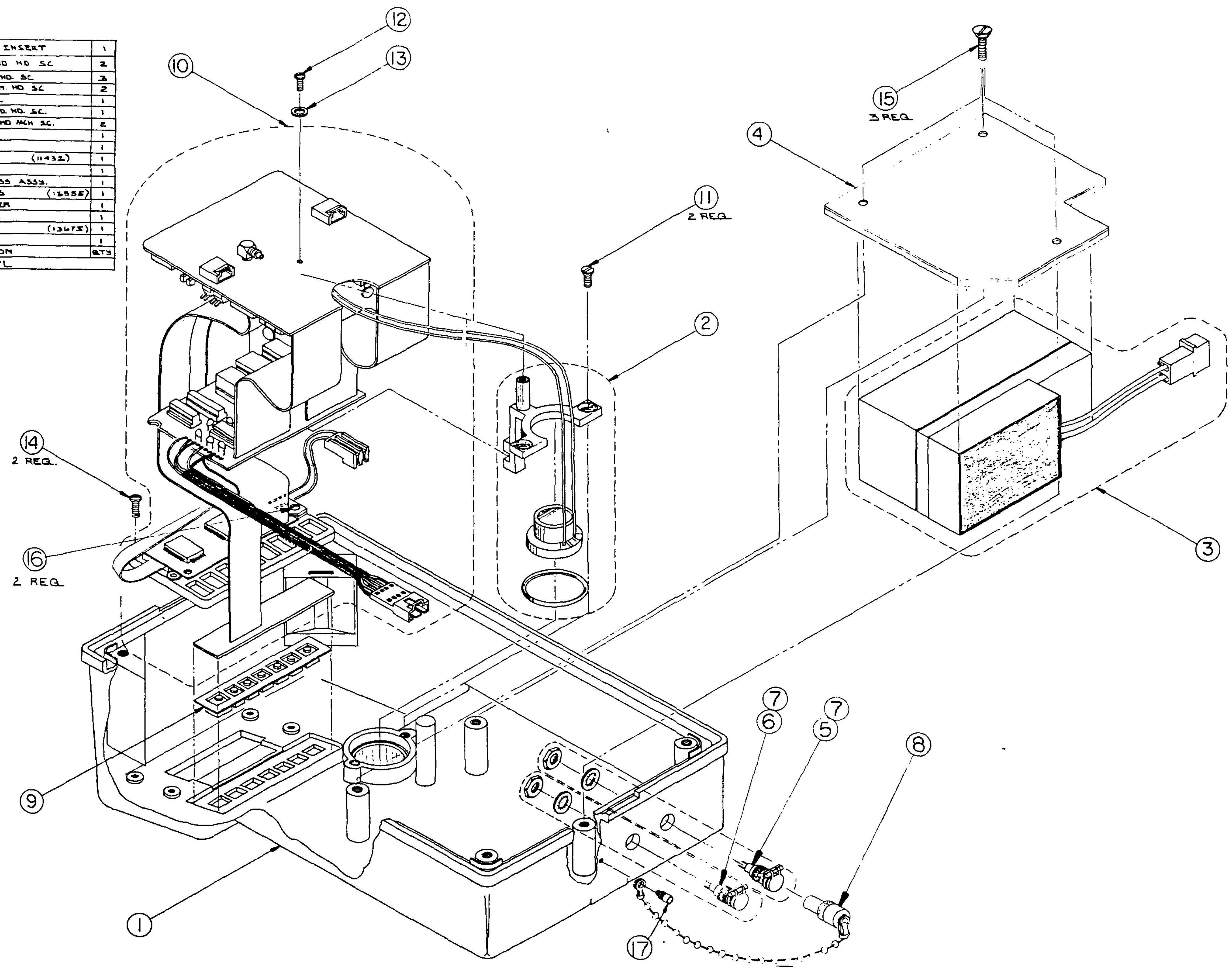


Figure E.1
Case Top Assembly

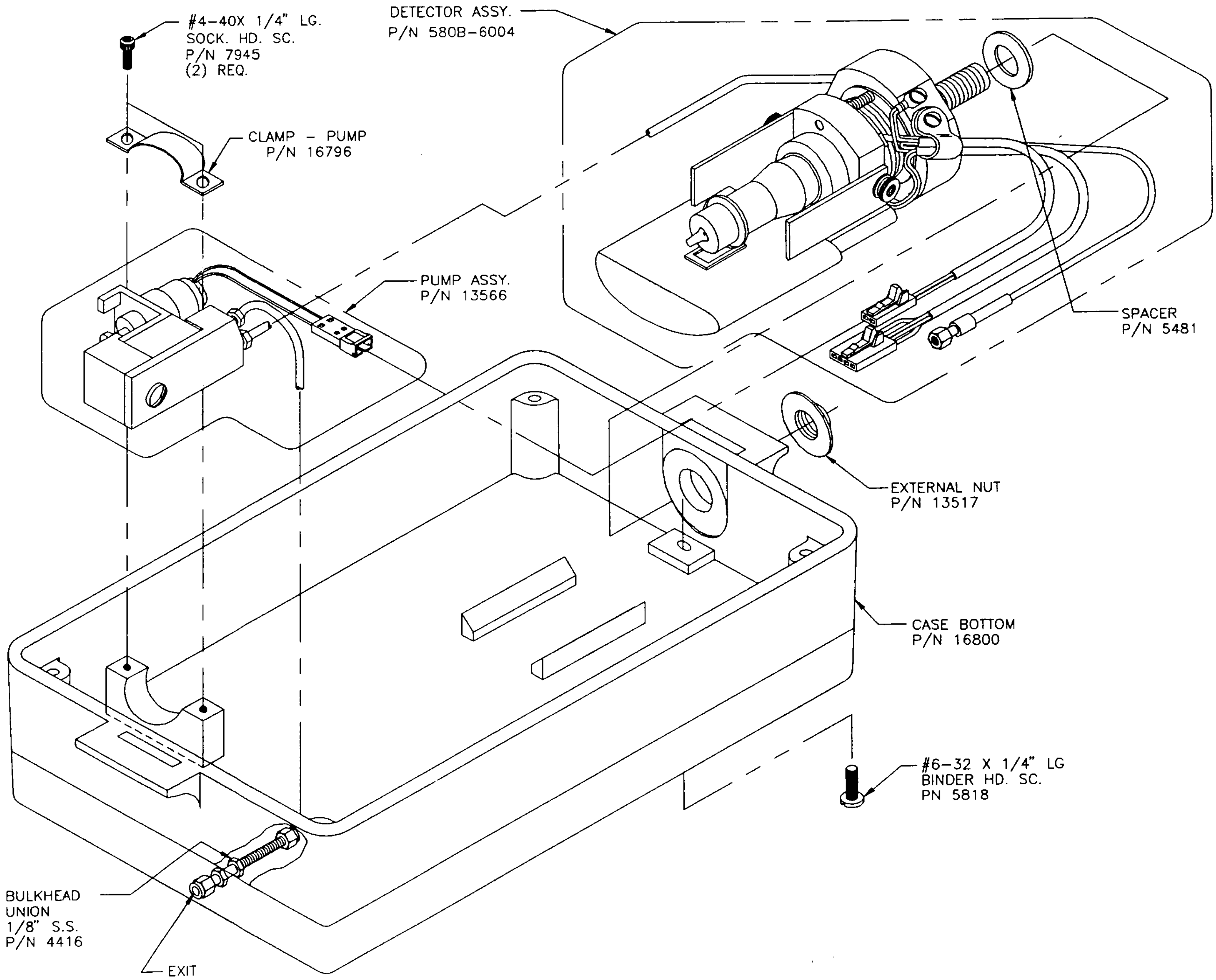


Figure E.2
Case Bottom Assembly

APPENDIX F
COMMON ORGANIC SOLVENTS AND GASES DATA SHEET

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^{o}C)*	I.P. (EV)**	TWA (PPM)***
Acetaldehyde	44.05	0.788	21	10.21	200
Acetamide	59.07	1.159	221	9.77	
Acetic Acid	60.05	1.049	116-117	10.37	10
Acetic Anhydride	102.1	1.10	138-117	9.88	5
Acetone	58.1	0.79	56	9.69	1000
Acetonitrile	41.1	0.79	82	12.22	40 cell
Acetophenone	120.15	1.033	202	9.27	
Acetyl Bromide	122.96	1.52	75-75	10.55	
Acetyl Chloride	78.50	1.104	52	11.02	
Acetylene	26.02	0.90		11.41	
Acrolein	56.06	0.8389	53	10.10	0.1
Acrylonitrile	53.06	0.8004	77	10.91	10
Allyl Alcohol	58.1	0.85	96-98	9.67	2
Allyl Chloride	76.5	0.94	44-46	9.9	1
Aniline	93.1	1.02	184	7.70	5
Anisole	108.13	0.9956	154	8.22	
Ammonia	17.03	gas		10.15	
Arsine	77.9	gas			0.05
Benzaldelyde	106.12	1.053	178-185	9.53	
Benzene	78.1	0.88	80	9.25	1
Benzonitrile	103.12	1.010	188	9.71	
Benzotriflouride	146.11	1.1886	102	9.68	
Benzyl Chloride	126.6	1.10	177-181	9.14	1
Biphenyl	154.21	0.992	255		
Bromine	159.81	3.1023	58.8	10.55	0.1
Bromobenzene	157.02	1.495	156	8.98	
1-Bromobutene	137.03	1.276	100-04	10.13	
2-Bromobutene	137.03	1.255	91	9.98	
1-Bromo-2-Chlorethene	143.42	1.723	106-07	10.63	
Bromochloromethane	129.39	1.991	68	10.77	
1-Bromo-2-Flourobenzene	175.01	1.593	150	8.99	
Bromoform	252.8	2.9	150-01	10.47	0.5
1-Bromo-2-methyl propane	137.03	1.260	90-92	10.09	
2-Bromo-2-methyl propane	137.03	1.189	72-74	9.89	
1-Bromopentane	151.05	1.218	130	10.10	
2-Bromopropane	123.00	1.354	71	10.18	
2-Bromopropene	123.00	1.310	59	10.08	
1-Bromopropene	120.98	1.413	58-63	9.30	
3-Bromopropene	120.98	1.398	70-71	9.70	
2-Bromothiophene	163.04	1.684	149-151	8.63	
M-Bromotoluene	171.04	1.4099	183.7	8.81	
O-Bromotoluene	171.04	1.431	58.60	8.79	
P-Bromotoluene	171.04	1.431	184	8.67	
1,3-Butadiene	54.1	gas	9.07		1000
Butane	58.12	gas	10.63		
	90.19	.842	9.14		

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^{o}C)*	I.P. (EV)**	TWA (PPM)***
2-Butanone	72.1	0.81	80	9.53	200
1-Butene	56.10	0.6255		9.58	
N-Butyl Acetate	116.2	0.88	124-26	10.01	150
S-Butyl Acetate	116.2	0.88	111-12	9.91	150
N-Butyl Alcohol	74.1	0.81	117.7	10.04	100
N-Butyl Amine	73.1	0.73	73	78	5
S-Butyl Amine	73.1	0.73	63	8.70	5
T-Butyl Amine	73.1	0.73	46	8.64	5
N-Butyl Benzene	134.21	0.8604	183	8.69	
S-Butyl Benzene	134.21	0.8604	173-04	8.68	
T-Butyl Benzene	134.21	0.8669	169	8.68	
N-Butyraldehyde	72.10	0.8016	75	9.86	
N-Butyric Acid	88.10	0.959	162	10.16	
N-Butyronitrile	69.10	0.7954	115-17	11.67	
Camphor	152.2	0.99	204	8.76	2 mg/m
Carbon Dioxide	44.01	gas		13.79	5000
Carbon Monoxide	28.01	gas		14.01	50
Carbon Tetrachloride	153.8	1.59	77	11.47	10
Chlorine	70.90	gas		11.48	1 cell
Chlorobenzene	112.6	1.10	132	9.07	75
Chloroform	119.4	1.48	60.5-61.5	11.37	50 cell
1-Chloro-2-Methylpropane	92.57	.883	68-69	10.66	
2-Chloro-2-Methylpropane	101.64	.851	51-52	10.61	
1-Chloropropane	78.54	.892	46-47	10.82	
2-Chloropropane	78.54	.859	34-36	10.78	
3-Chloropropane	76.53	.939	44-46	10.04	
2-Chlorothiophene	118.59	1.286	127-29	8.68	
M-Chlorotoluene	126.58	1.076	160-162	8.83	
O-Chlorotoluene	126.58	1.0826	157-159	8.83	
P-Chlorotoluene	126.58	1.0697	162	8.70	
M-Cresol	108.1	1.034	203	8.52	5 cell
O-Cresol	108.1	1.048	191	8.50	5 cell
P-Cresol	108.1	1.034	202	8.38	5 cell
Crotonaldehyde	70.09	0.853	104	9.73	2
Cumene	120.2	0.86	152-154	8.75	50
Cyanogen	52.04	0.9537		13.80	
Cyclohexane	84.2	0.81	80.7-81	9.98	300
Cyclohexane	100.2	0.96	160-161	10.0	50
Cyclohexanone	98.1	0.95	155	9.14	50
Cyclohexene	82.1	0.81	83	8.95	300
Cyclo-Octatetraene	104.15	0.925	142-43	7.99	
Cyclopentane	70.13	0.7460	50	10.53	
Cyclopentanone	84.11	1.4366	130-131	9.26	
Cyclopentene	68.12	0.744	44	9.01	
Cyclopropane	42.08	gas		9.91	
Diborane	27.68	gas		11.00	
Diazomethane	42.0	gas		9.0	0.2

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^{o}C)*	I.P. (EV)**	TWA (PPM)**
Dibromodiflouromethane	209.83	2.297	22-23	11.07	
1,2-Dibromoethane	187.87	2.180	131-32	9.45	
1,3-Dibromopropane	201.90	1.937	167	10.07	
Dibutylphthlate	278.3	1.04	340		5 mg/m
M-Dichlorobenzene	147.01	1.288	172-73	9.12	50
O-Dichlorobenzene	147.01	1.306	179-180	9.07	50
P-Dichlorobenzene	147.01	1.241	173	8.94	75
1,1-Dichlorethane	99.0	1.18	57	11.06	100
1,2-Dichlorethane	98.96	1.256	83	11.12	
1,2-Dichlorethylene	97.0	1.28	46-60	9.66	200
Dichloromethane	84.93	1.325	39.8-40	11.35	
1,2-Dichloropropane	112.99	1.156	95-96	10.87	
1,3-Dichloropropane	112.99	1.190	120-22	10.85	
2,3-Dichloropropane	110.97	1.204	94	9.82	
N,N-Diethyl Acetamide	115.18	0.925	182-86	8.60	
Diethylamine	73.1	0.71	55	8.01	25
Diethyl Ether	74.12	0.7134	34.6	9.53	
N.N-Diethyl Formamide	101.15	0.908	176-77	8.89	
Diethyl Ketone	86.13	0.816	102	9.32	
Diethyl Sulfide	90.19	.837		8.43	
Diethyl Sulfite	138.19	1.883	158-60	9.68	
Dihydropyran	84.12	0.922	86	8.34	
Diisopropylamine	101.2	0.72	84	7.73	5
1,1-Dimethoxyethane	90.12	0.863	64	9.65	
N,N-Dimethyl Acetamide	87.12	0.937	164.5-66	8.81	10
Dimethyl Amine	45.1	0.68		8.24	10
N,N-Dimethyl Aniline	122.2	0.96	193-94	7.13	
2,2-Dimethyl Butane	86.18	0.649	50	10.06	
2,3-Dimethyl Butane	86.18	0.662	50	10.02	
3,3-Dimethyl Butanone	100.16	0.801	106	9.17	
N,N-Dimethyl Formamide	73.09	0.9445	153	9.12	10
Dimethlyl Sulfide	63.13	0.846	38	8.69	
P-Dioxane	88.1	1.03	100-102	9.13	100
Dipropyl Amine	101.19	0.738	105-110	7.84	
Durene	134.12	0.84	80-82	8.03	
Epichlorohydrin	92.5	1.18	115-117		5
Ethane	30.07	gas		11.65	
Ethanethiol	62.13	0.8315	35	9.29	
Ethyl Acetate	88.1	0.90	76.5-77.5	10.11	400
Ethyl Alcohol	46.1	0.80	78	10.48	1000
Ethyl Amine	45.1	0.69	19.20	8.86	10
Ethyl Benzene	106.2	0.87	136	8.76	100
Ethyl Bromide	109.0	1.45	37-40	10.29	200
Ethyl Butyl Ketone	114.2	0.82	146-49	9.02	50
Ethyl Chloride	64.52	0.9214		10.98	1000
Ethyl Disulfide	122.25	0.993	153	8.27	
Ethylene Dibromide	187.9	2.17	131-132	10.52	20
Ethylene Dichloride	99.0	1.26	83	11.32	50

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^{o}C)*	I.P. (EV)**	TWA (PPM)**
Ethyl Ether	74.1	0.73	34.6	9.59	400
Ethyl Formate	74.1	0.92	52-54	10.61	100
Ethyl Iodide	155.98	1.950	67-73	9.33	
Ethyl Isothiocyanate	87.15	1.003	60	9.14	
Ethyl Methyl Sulfide	76.16	0.842	66-67	8.55	
Ethyl Nitrate	75.07	0.90	112	11.22	
Ethyl Propionate	102.13	0.891	99	10.00	
Ethyl Thiocyanate	87.14	1.007		9.89	
Ethynylbenzene	102.13	0.9300	142-44	8.82	
Fluorine	37.99	gas		15.70	0.1
Flourobenzene	96.10	1.024	85	9.20	
O-Fluorophenol	112.10	1.256	172-74	8.95	
M-Fluorotoluene	110.13	0.997	178	8.92	
O-Fluorotoluene	110.13	1.004	172-172	8.92	
P-Fluorotoluene	110.13	1.001	185	8.79	
Formaldehyde	30.03	1.083		10.87	3
Formahide	45.04	1.1334	210	10.25	
Formic Acid	46.02	1.220	110-101	11.05	
2-Furaldehyde	96.09	1.160	182	9.21	250
Furan	68.07	0.9371		8.89	
Heptane	100.2	0.68	98	10.08	500
2-Heptanone	114.18	0.8068	149-50	9.33	
Hexane	86.2	0.66	68-69	10.18	500
1-Hexane	84.16	0.673	64	9.46	
Hexone	100.2	0.80		9.53	100
Hydrogen	2.017	gas		15.43	
Hydrogen Bromide	80.92	gas		11.62	3
Hydrogen Chloride	36.47	gas		12.74	5 cell
Hydrogen Cyanide	27.03	0.687		13.91	10
Hydrogen Flouride	20.01	gas		15.77	3
Hydrogen Iodide	127.93	gas		10.38	
Hydrogen Selenide	80.98	gas		9.88	0.05
Hydrogen Sulfide	34.08	gas		10.46	20 cell
Hydrogen Telluride	129.63	gas		9.14	
Iodine	253.81	4.93		9.28	0.1 cell
Iodobenzene	204.02	1.8384	188	8.73	
1-Iodobutene	184.02	1.617	130-31	9.21	
2-Iodobutene	184.02	1.4991	119-120	9.09	
1-Iodo-2-Methylpropane	184.02	1.599	120-21	9.18	
1-Iodopentane	198.05	1.517	154-55	9.19	
1-Iodopropane	169.99	1.743	101-02	9.26	
2-Iodopropane	169.99	1.703	88-90	9.17	
O-Iodotoluene	218.04	1.713	211	8.62	
M-Iodotoluene	218.04	1.698		8.61	
P-Odotoluene	218.04		211-5	8.50	
Isoamyl Acetate	130.2	0.88	142	9.94	
Isoamyl Alcohol	88.2	0.81	130-1	10.42	100

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^{o}C)*	I.P. (EV)**	TWA (PPM)**
Isobutyl Amine	73.14	0.724	64-71	8.70	
Isobutyl Formate	102.13	0.885	98.4	10.46	
Isobutylene	56.11	0.5942	-6.9	9.23	
Isobutyraldehyde	72.11	0.794	63	9.74	
Isobutyric Acid	88.11	0.950	153-54	10.02	
Isoctane	114.2	0.70	98-99	17.9	400
Isopentane	114.23	0.692	30	10.32	
Isoprene	68.12	0.681	34	8.85	
Isopropyl Acetate	102.1	0.87	85	9.99	250
Isopropyl Alcohol	60.1	0.79		10.16	400
Isopropyl Amine	59.1	0.69	33-34	8.72	5
Isopropyl Benzene	120.2	0.86	152-54	8.75	50
Isopropyl Ether	102.2	1.37	68-69	9.20	500
Isovaleraldehyde	86.13	0.785	90	9.71	
2,3-Lutidine	107.15	0.945	162-63	8.85	
2,4-Lutidine	107.15	0.927	159	8.85	
2,6-Lutidine	107.15	0.9252	143-45	8.85	
Malaic Anhydride	98.1	0.93	200	11.1	
Mesitylene	120.19	0.8637	162-64	8.40	
Mesityl Oxide	98.14	0.8592	129	9.08	
Methane	16.04	gas		12.98	
Methanethiol	48.11	0.96		9.44	
N-Methyl Acetamide	73.10	0.957	204-05	8.90	
Methyl Acetate	74.08	0.9279	57.5	10.27	
Methyl Acrylate	86.1	0.96	80	9.9	10
Methyl Amine	31.06	gas	48	8.97	
Methyl Bromide	95.0	gas		10.53	
2-Methyl-1-Butane	70.16	0.650	31	9.12	
3-Methyl-1-Butane	70.14	0.627	20	9.51	
3-Methyl-2-Butane	70.14	0.643		8.67	
Methyl Butyl Ketone	100.6	0.83	127	9.34	100
Methyl Butyrate	102.13	0.898	102-103	10.07	
Methyl Chloride	50.5			11.28	100
Methyl Cyclohexane	98.19	0.770	101	9.85	
Methyl Disulfide	94.20	1.046	109	8.46	
Methyl Ethyl Ketone	72.10	0.805	80	9.53	
Methyl Formate	60.1	1.34	34	10.815	100
2-Methyl Furan	82.10	0.827	63-66	8.39	
Methyl Iodide	142.0	2.28	41-43	9.54	5
Methyl Isobutyl Ketone	100.2	0.80	117-18	9.30	100
Methyl Isobutyrate	102.13	0.891	90	9.98	
Methyl Isopropyl Ketone	86.12	0.805	94-95	9.32	
Methyl Isothiocyanate	73.12		37-39	9.25	
Methyl Methacrylate	100.1	0.94	100	9.9	100
1-Methyl Napthalene	142.20	1.001	240-243	7.96	
2-Methyl Napthalene	142.20	1,000	241-242	7.96	
2-Methyl Pentane	86.18	0.653	62	10.12	
3-Methyl Pentane	86.18	0.664	64	10.08	
Methyl Propionate	88.11	0.915	79	10.15	

* BP - Boiling Point Degrees Centigrade
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*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^oC)*	I.P. (EV)**	TWA (PPM)**
Methyl Propyl Ketone	86.13	0.809	100.01	9.38	
2-Methyl Styrene	165.4	1.068	131	10.07	
Monomethyl Aniline	107.16	0.989			
Monomethyl Hydrazine	46.1	0.87			
Morpholine	87.1	1.01	129	8.88	20
Nephthalene	93.7	1.16	217.7	8.12	10
Nitric Oxide	162.2	1.01		9.25	
P-Nitroaniline	138.1				1.0
Nitrobenzene	123.1	1.21	210-211	9.92	1.0
4-Nitrobiphenyl	199.2				
P-Nitrochlorobenzene	157.6	1.52		9.96	1.0 mg/m
Nitrogen Dioxide	46.01	1.448		9.78	
Nitroethane	75.1	1.38	112	10.81	100
Nitromethane	61.0	1.13	100.8-101	11.08	100
1-Nitropropane	89.1	0.99	131-32	10.88	25
2-Nitropropane	89.1	0.98	120	10.71	25
N-Nitrosodimethylamine	74.1	1.00	153	9.07	
Nitrotoluene	137.1	1.16	225-238	11.63	5
Oxygen	31.9988	gas		12.08	
Ozone	48.00	gas		12.08	
Pentaborane	63.17	0.61		10.40	
Pentane	72.15	0.62638	35	10.35	
2,4-Pentanedione	70.13	0.6429	140.4	8.87	
1-Pentene	70.13	0.6503	29.9-30.1	9.50	
Phenetol	122.16	0.967	169-70	8.13	
Phenol	94.1	1.07	182	8.50	5
Phenyl Hydrazine	108.1	1.1	238-41	7.86	5
Phenyl Isocyanate	119.12	1.0887	162-63	8.77	
Phenyl Isothiocyanate	135.18	1.1288	221	8.52	
Phosgene	98.9	gas		11.77	0.4 mg/m
Phosphine	34.0	gas			0.3
Phosphorous Pentachloride	208.2	1.6		10.7	1 mg/m
Phosphorous Trichloride	137.3	1.57	76	10.5	
2-Picoline	93.12	0.950	128-29	9.02	
3-Picoline	93.12	0.9613	144	9.02	
4-Picoline	93.12	0.9571	145	9.04	
Propane	44.09	gas		11.07	
1-Propanethiol	76.16	0.841	67-68	9.20	
Propiolactone	72.06	1.146	162	9.70	
Propionic Acid	74.08	0.99336	141	10.24	
Propionaldehyde	58.08	0.8071	46-50	9.98	
Propionitrile	55.08	0.7818	97	11.84	
N-Propyl Acetate	102.1	0.84	120	10.04	200
Propyl Alcohol	60.10	0.804	97	10.20	
Propyl Amine	59.11	0.719	48	8.78	
Propyl Benzene	120.20	0.862	159	8.72	
Propylene	42.08	gas		8.73	
Propylene Oxide	58.08	0.859	34	10.22	

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (^{O}C)*	I.P. (EV)**	TWA (PPM)***
Methyl Propyl Ketone	86.13	0.809	100.01	9.38	
2-Methyl Styrene	165.4	1.068	131	10.07	
Monomethyl Aniline	107.16	0.989			
Monomethyl Hydrazine	46.1	0.87			
Morpholine	87.1	1.01	129	8.88	20
Napthalene	93.7	1.16	217.7	8.12	10
Propyl Ether	102.17	0.7360	88.90	9.27	
Propyl Formate	88.10	0.901		10.54	
Pyrene	202.3	gas		7.41	
Pyridine	79.1	0.98	115	9.32	5
Pyrrole	67.09	0.9691	131	8.20	
Styrene	104.14	9.9059	145-146	8.47	
Styrene Oxide	120.2	1.054	194	9.04	
Tetrachloroethylene	165.9	1.63	121	9.32	100
Tetrahydrofuran	72.10	0.8892	67	9.54	
Tetrahydropyran	86.13	0.8814	88	9.26	
Thiophene	84.1	1.53	84	8.86	
Toluene	93.13	0.866	111	8.82	
O-Toluidine	107.2	1.01	199-200	7.44	5
Trichloroethene	131.40	1.4649	87	9.45	
Triethylamine	101.19	1.069	88.18	7.50	
Trimethyl Amine	59.11	0.636	3-4	7.82	
2,2,4-Trimethyl Pentane	114.23	0.692	98-99	9.86	
Tripropyl Amine	143.27	0.753	155-58	7.23	
Valeraldehyder	86.13	0.8095	103	9.82	
Valeric Acid	102.13	0.939	185	10.12	
Vinyl Acetate	118	0.94	72-73	9.19	10
Vinyl Bromide	106.96	1.517	16	9.80	
Vinyl Chloride	62.5	gas		10.00	1
Water	18.016	1.00	100	12.59	
M-Xylene	106.16	0.8684	138-39	8.56	100
O-Xylene	106.16	0.8801	143-45	8.56	100
P-Xylene	106.16	0.8614	138	8.45	100

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

APPENDIX G

DILUTION PROBE OPERATION

(Not investigated as part of UL classified product)

G.1 GENERAL

The dilution probe is constructed of stainless steel and Teflon, with a charcoal filter mounted on the dilution inlet. The purpose of the charcoal filter is to provide hydrocarbon free air to the probe assembly so that the dilution of the incoming sample is not affected by the dilution air. The charcoal filter should be changed every 3 months to ensure proper operation, eliminating the problem of hydrocarbon breakthrough. It is easy to evaluate the performance of the charcoal, by challenging the Model 580A with hydrocarbon free air, then introducing a standard through the charcoal filter, with the inlet of the probe plugged. If there is breakthrough, a reading other than zero will be observed on the readout.

Another important part of the dilution probe is the 10 micron filter that is placed in the inlet of the probe assembly. The flow through this may reduce with time, as dirt collects on the inlet filter. This filter should be changed on a regular basis, depending upon the operator's experience and the environment in which he is working.

It is important to realize that the charcoal filter is not a totally efficient device. This does not cause a problem with the 580A, however, because the photoionization detector does not respond to ethane or methane.

G.2 TECHNICAL CONSIDERATION

Need For Dilution - The Model 580B dilution system was developed to increase the dynamic range of the Model 580A. As the instrument is manufactured, it has a workable range of 0 to 2,000 ppm. Above this upper limit, the detector is found to be non-linear. It does not absorb ethane or methane. The 580B will "lock out" for concentrations above 2,000 ppm. To meet the requirements of fugitive emission measurements as defined in EPA Method 21, there is the need to make measurements above the 2,000 ppm level. To accomplish this using a detector system that is limited by linearity, a dilution probe was developed. this probe provides a nominal 10 to 1 dilution ratio, increasing the dynamic range of the Model 580B from 2,000 to 20,000 ppm.

G.3 CALIBRATION OF THE DILUTION PROBE

The dilution probe is not factory calibrated. It has been tested and evaluated proper performance. It is the responsibility of the operator to properly calibrate the dilution probe.

The following is a simple procedure for this activity:

1. The performance of the 580B should have previously seen verified and calibrated.

2. Place the 580B in close proximity to a standard with the appropriate range. For example, if the instrument is to be used in a 5,000 ppm sampling range, then a standard of that concentration should be selected.

3. Connect the dilution probe making sure that the charcoal filter and the 10 micron filter are in place to the front of the 580B.

4. Challenge the instrument with the new standard gas and adjust the micro metering valve until a tenth of the reading is seen on the instrument readout.

5. As in the example of the 5,000 ppm standard, 500 ppm should be seen on the readout.

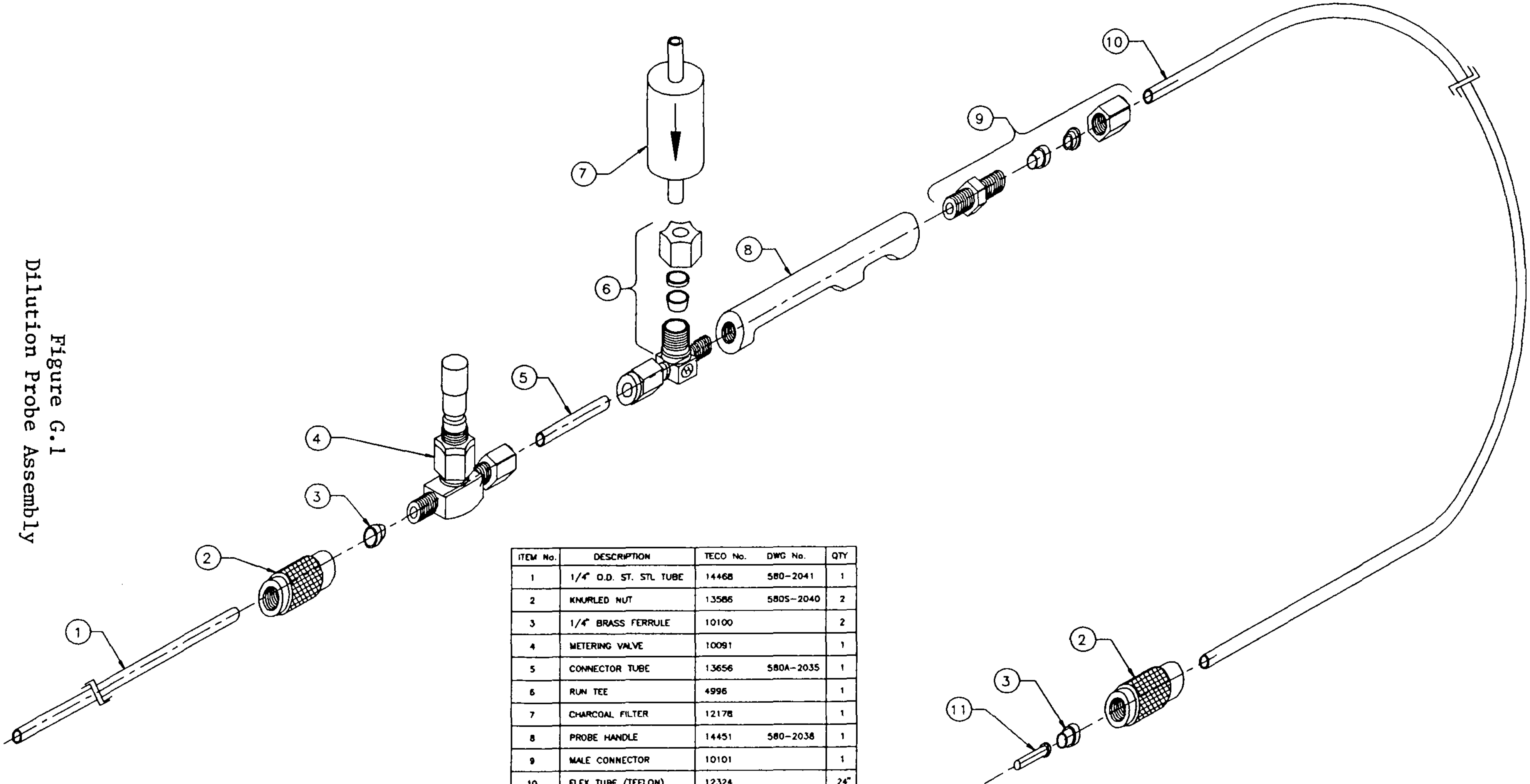
6. This is all that is required to calibrate the 580A or 580B.

   Note: It is important that both zero and span of of the 580A have been properly verified prior to initiating this procedure. It is very simple after using the dilution probe, to remove it and recheck the performance of the instrument on your low concentrator standard.

7. It should be noted that due to the environment that you are operating in, there may be a change in the back pressure of the charcoal filter and the 10 micron filter. Any changes in these over a period of time will cause a change in the split ratio of the dilution probe. Therefore, it is important to calibrate the dilution probe as regularly as you calibrate the 580A or 580B.

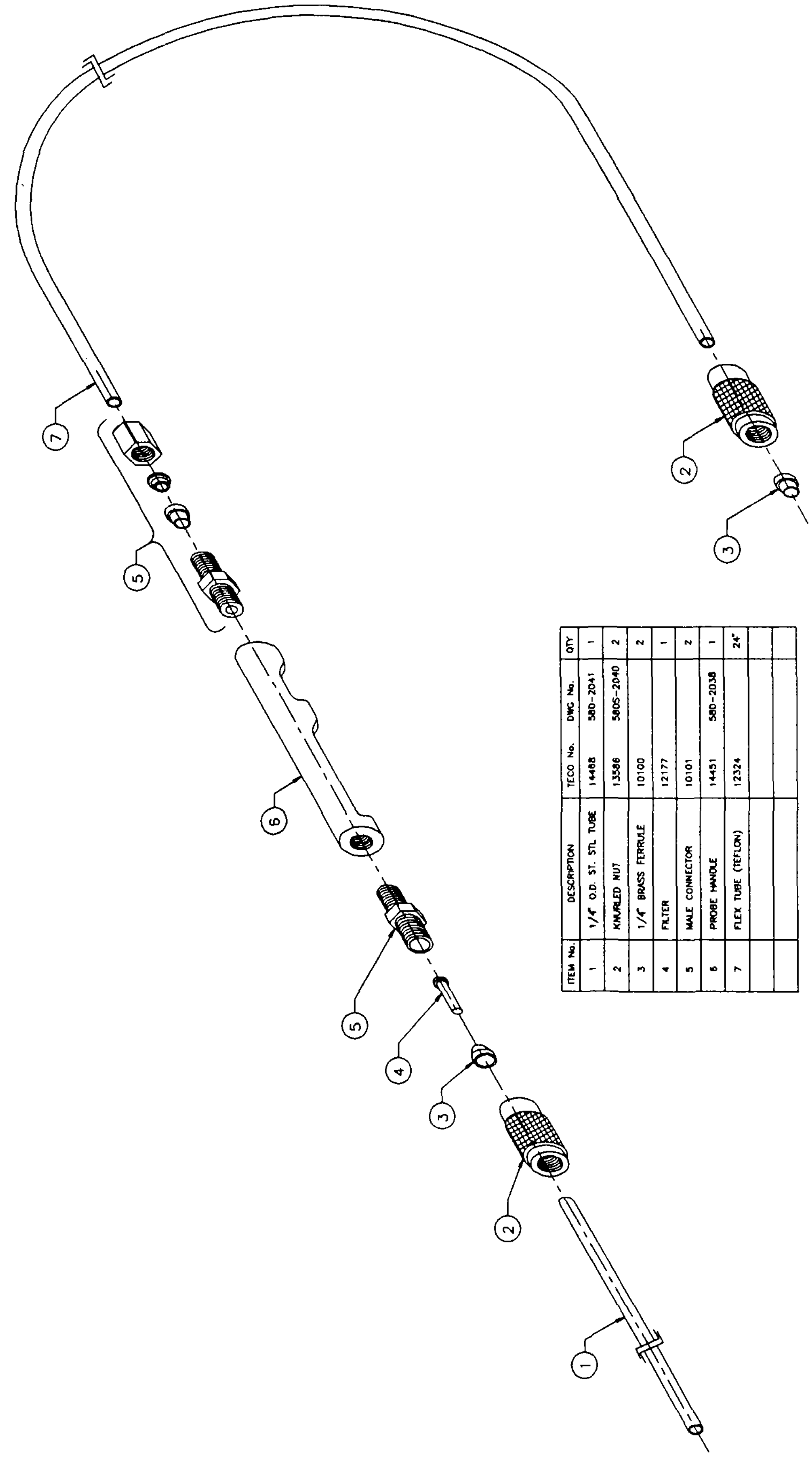
REPLACEMENT PARTS

1.	Inlet Probe Assembly	580A-6016
2.	Charcoal Filter	3150-0018
3.	Inlet Filter 10 Micron	3150-0017



ITEM No.	DESCRIPTION	TECO No.	DWG No.	QTY
1	1/4" O.D. ST. STL TUBE	14468	580-2041	1
2	KNURLED NUT	13586	580S-2040	2
3	1/4" BRASS FERRULE	10100		2
4	METERING VALVE	10091		1
5	CONNECTOR TUBE	13656	580A-2035	1
6	RUN TEE	4996		1
7	CHARCOAL FILTER	12178		1
8	PROBE HANDLE	14451	580-2038	1
9	MALE CONNECTOR	10101		1
10	FLEX TUBE (TEFLON)	12324		24"
11	FILTER	12177		1

Figure G.1
Dilution Probe Assembly



ITEM No.	DESCRIPTION	TECO No.	DWG No.	QTY
1	1/4" O.D. ST. STL TUBE	14488	580-2041	1
2	KNURLED NUT	13586	580S-2040	2
3	1/4" BRASS FERRULE	10100		2
4	FILTER	12177		1
5	MALE CONNECTOR	10101		2
6	PROBE HANDLE	14451	580-2038	1
7	FLEX TUBE (TEFLON)	12324		24"

Figure H.1
Probe Extension Assembly

APPENDIX I

INSTRUCTION SHEET
OPTION 11 WATER TRAP ASSEMBLY

(Not investigated as part of the UL classified product)

INSTALLATION

The water trap assembly (16846) is to be installed on the end of the 580 sample probe. The tygon tubing included is to be placed on the syringe side of the filter then connected to the probe. Refer to the drawing below.

USE

The water trap will effectively stop water from entering the instrument. Water traps can be re-used after drying at room temperature, but the user must be cautious of possible contamination. Contaminated traps should be discarded.

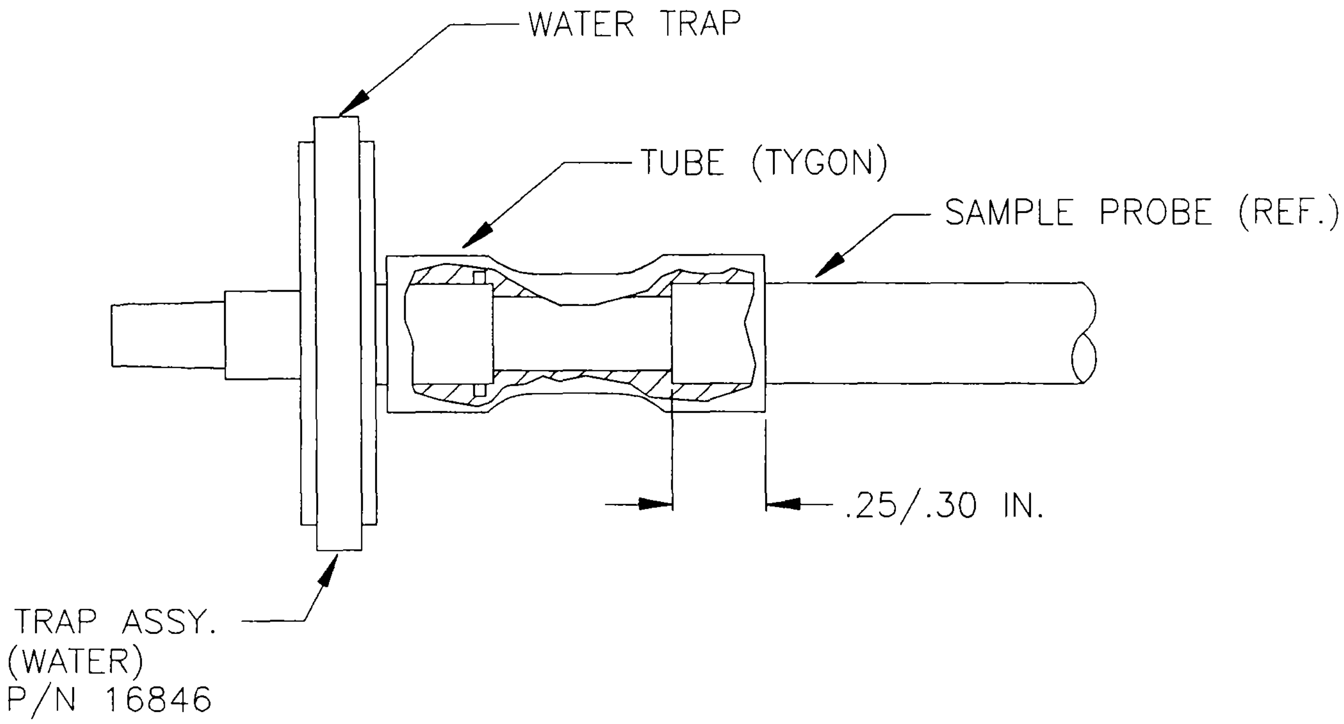
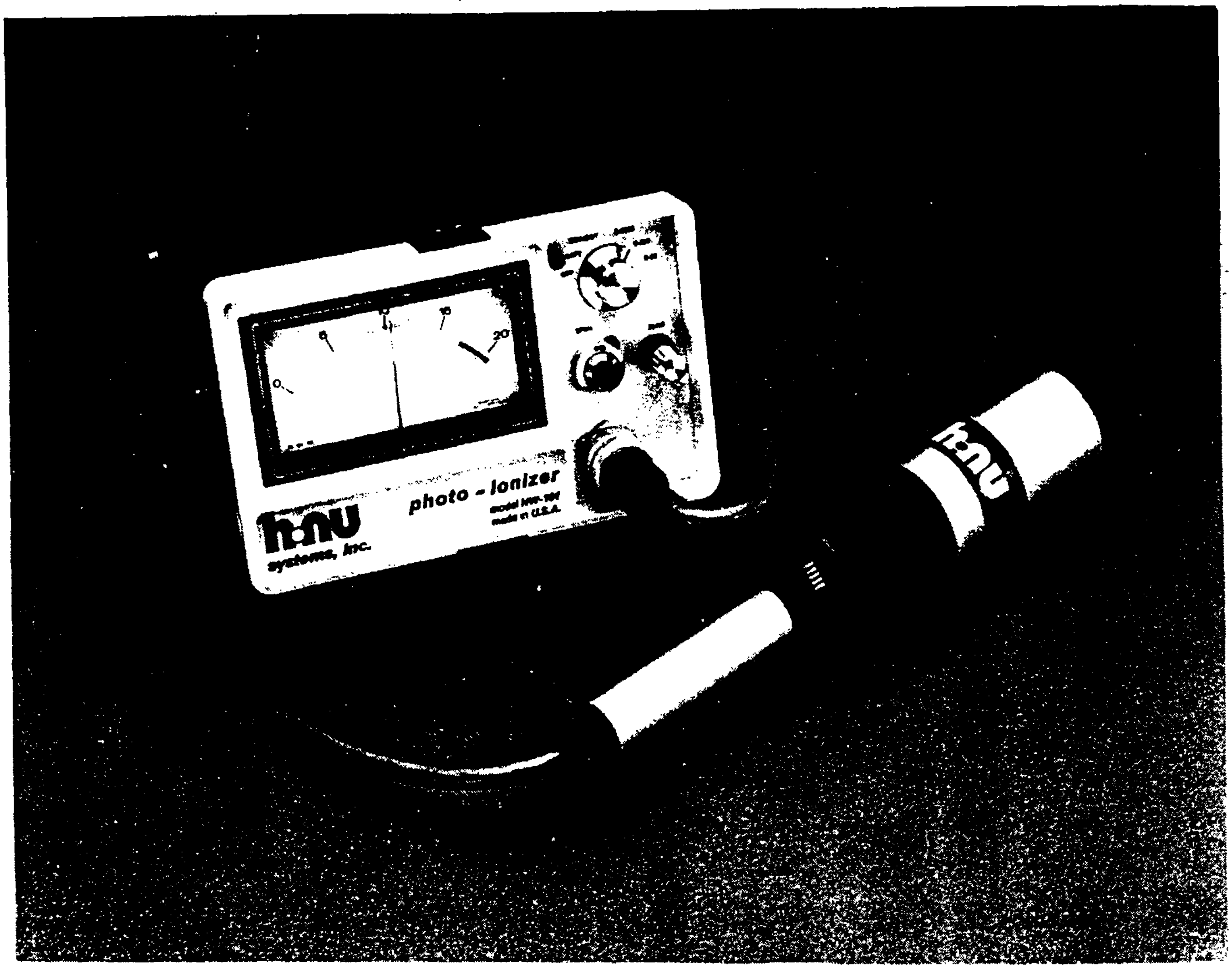


Figure I.1
Water Trap Assembly

INSTRUCTION MANUAL 970297



hnu

MODEL HW-101
Portable Hazardous Waste Analyzer

Preliminary Version

Published in the U.S.A.

PRELIMINARY

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SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe all safety regulations. Do not replace components or make any adustments inside the equipment with the high voltage supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the OFF position, due to charges retained by capacitors. To avoid casualties, always remove power and discharge and ground a circuit before touching it.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into the equipment for the purpose of servicing or adjusting except in the presence of someone who is capable of rendering aid.

RESUSCITATION

Personnel working with or near high voltage should be familiar with modern methods of resuscitation. Such information may be obtained from the Bureau of Medicine and Surgery.

The following warnings appear in the text in this volume, and are repeated here for emphasis.

WARNINGS: Do not observe the light source closer than 6 inches. When necessary, observe only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight.

A high reading on the meter should be cause for protective action since the instrument measures gases in the vicinity of the operator.

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise, high voltages of -1200 VDC, will be present.

Use great care when operating the analyzer with the readout assembly outside the case due to the presence of -1200 V DC.

When conducting tests on analyzer in open condition, exercise great care due to presence of high voltage.

CHAPTER 1

GENERAL INFORMATION AND SAFETY PRECAUTIONS

1-1 SAFETY PRECAUTIONS

Safety precautions to be exercised in the use and repair of this equipment are described in the Safety Summary in the front section of this manual.

1-2 INTRODUCTION

This manual describes the operation, maintenance and parts list for the Photoionization Analyzer, Model HW 101, HNU Systems Inc., 160 Charlemont St., Newton, MA 02161, tel: 617-964-6690.

1-3 EQUIPMENT DESCRIPTION

The Photoionization Analyzer is a portable instrument used to detect and measure the concentration of a variety of hydrocarbon gases in various atmospheres. The analyzer consists of a probe and a readout assembly (see Figure 1-1). The probe contains the sensing and amplifying circuitry; the readout assembly contains the meter indicator, controls, and power supply.

Reference data on the analyzer is given in Table 1-1. Physical characteristics of the equipment are given in Table 1-2.

Characteristics of equipment required for maintenance and calibration are given in Table 1-3.

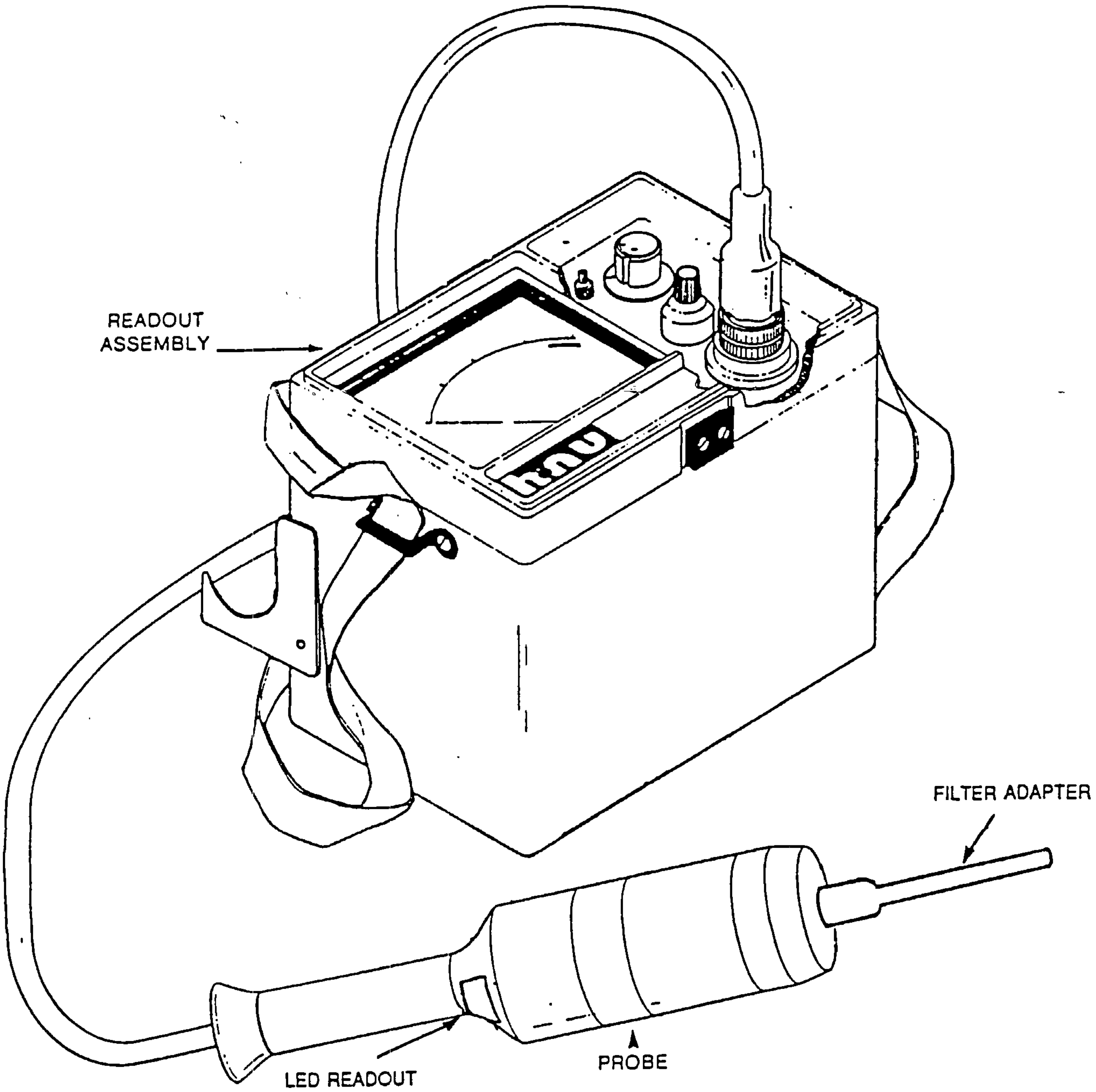


FIGURE 1-1
PHOTOIONIZATION ANALYZER
OPERATING CONDITION

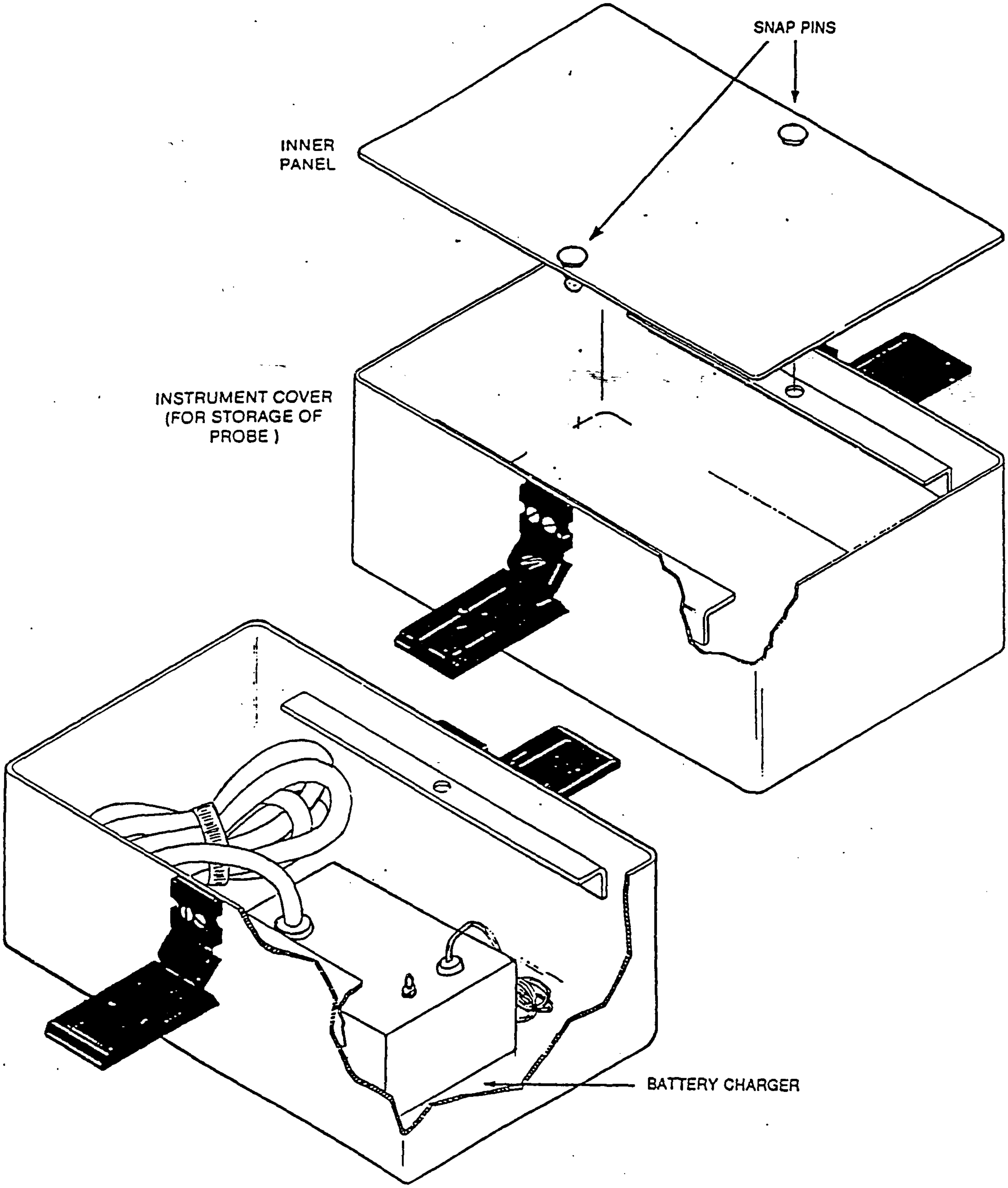


FIGURE 1-2
BATTERY CHARGER
STORAGE

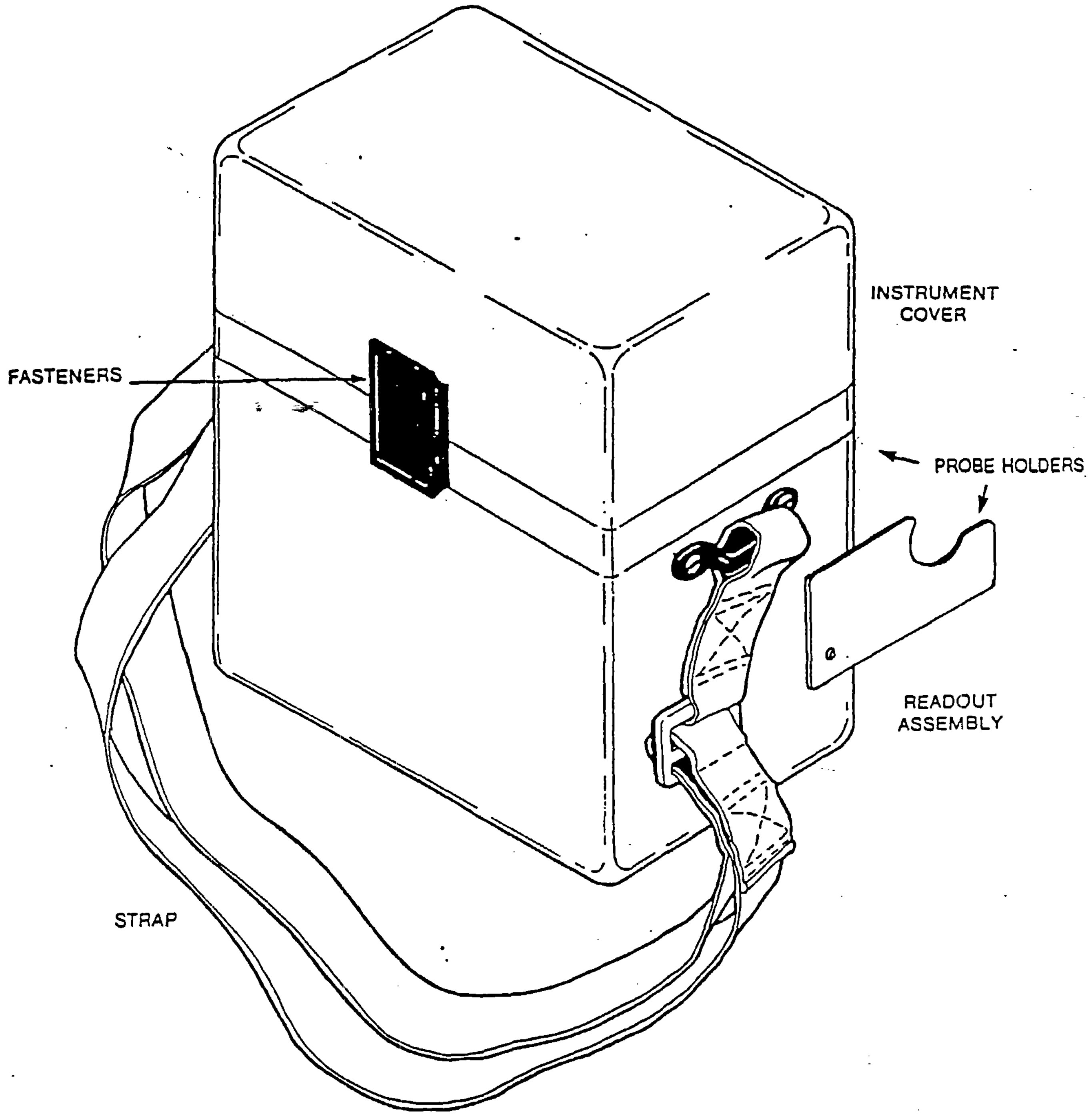


FIGURE 1-3
PHOTOIONIZATION ANALYZER
STORED CONDITION

TABLE 1-1

REFERENCE DATA

a) DESCRIPTION

Trace Gas Analazer	HNU Systems, Inc. Photoionization Analyzer Model HW 101

b) FUNCTIONAL CHARACTERISTICS (see NOTE)

Detection Range *	0.1 to 2000 ppm (parts per million by volume)
Minimum Detection Level *	0.1 ppm
Maximum Sensitivity *	0 to 20 ppm FSD (Full Scale Deflection)
Repeatability *	plus or minus 1% of FSD
Linear Range *	0.1 to 400 ppm
Useful Range *	0.1 to 2000 ppm
Response Time	Less than 5 seconds to 90% of FSD
Ambient Humidity	up to 90% RH
Operating Temperature Ambient	0 to 40 degrees C.
Operating Time on Battery	Approximately 10 hours
Battery Recharge Time after normal use	Approximately 6 hours
Battery Charger Power	120V AC, single phase, 50-60 cycle, 1.5 Amps

NOTE: Items marked with asterisk valid when span control set at 9.8 and measuring benzene. Values will vary for other compounds and conditions.

TABLE 1-2

EQUIPMENT SUPPLIED

Quan.	Name	Overall Dims CM (inches)	Weight Kg. (lbs)	Volume cm3 (cu ft.)
1	Photoionization Analyzer (stored condition)	21W x 13D x 24H (8 1/4 x 5 3/16 x 9 1/2)	4.7 (10.28)	6552 (0.23)
	Probe Assembly	6.0 Diam x 34.3L (2 3/8 x 13 1/2)	1.2 (2.7)	636 (0.023)
	Readout Assembly	21W x 13D x 16.5H (8 1/4 x 5 3/16 x 6 1/2)	3.4 (7.5)	4504 (0.16)
1	Battery Charger with cord	7.3W x 8.0D x 10.2L (2 7/8 x 3 1/8 x 4)	0.4 (0.9)	596 (0.021)

TABLE 1-3

EQUIPMENT REQUIRED, NOT SUPPLIED

Test Equipment Category (name)	Representative Test Eq. Model No.	Equipment Test Parameters	Application
Container/ Calib. Gas	HNU Systems Inc. cylinder, No. 101-350	Lightweight disposable steel cylinder containing 30 liters (3.6 cubic feet) at 300 lb/in2 and 70 oF. Contents to be 100 ppm of isobutylene in zero air +/- 10% -- rated concentration listed on cylinder.	Calibration
Regulator	HNU Systems Inc. regulator, NO. 101-351	Single stage regulator, flow preset at factory, 200-300 cc per minute, gage indicates pressure of tank contents	Calibration
Voltmeter	Multimeter, digital type	0 - 1500 V DC	Maintenance
Tubing	Latex	0.187 ID and 0.250 OD	Calibration
Compound, lamp cleaning	HNU part No. PA 101534-A1		Maintenance

CHAPTER 2

OPERATION

2-1 INTRODUCTION

The Photoionization analyzer is a portable instrument used to detect the concentration of a variety of trace gases in an atmosphere. The principal elements consist of a probe and a readout assembly. Associated elements consist of a battery charger and carrying straps.

2-2 CONTROLS AND INDICATORS

The controls and indicators are located on the panel of the readout assembly (see Figure 2-1) and are listed and described in Tables 2-1 and 2-2.

2-3 OPERATING PROCEDURES

The following are the procedures to be used in operating the analyzer:

a. Unclamp the cover from the main readout assembly.

b. Connect the probe cable to the 12 pin keyed connector on the readout assembly panel.

c. Screw the filter nozzle securely into the probe end cap. NOTE: This must be in place for proper operation.

d. Set the span control as specified by the initial factory calibration or by subsequent calibrations (see Section 4-4).

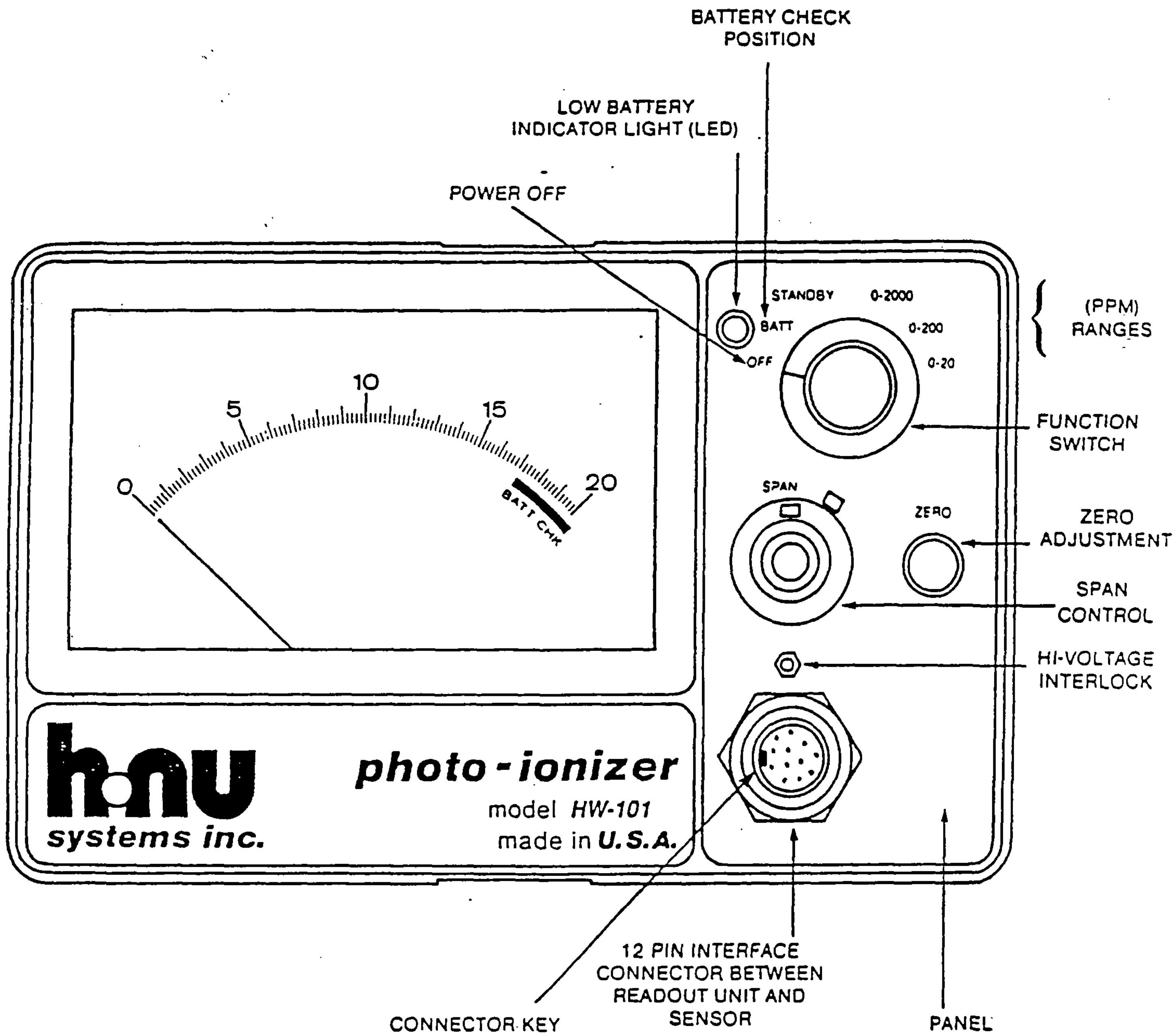


FIGURE 2-1
CONTROLS AND INDICATORS

e. Turn the function switch to the BATT (battery check) position. The needle on the meter will go to the green zone if the battery is fully charged. If the needle is below the green zone or if the Low Battery Indicator comes on, the battery must be recharged before the analyzer is to be used.

f. Turn the function switch to the STANDBY position. Turn the zero adjustment until the meter needle is at zero.

g. Calibrate the instrument as necessary (see para. 4.4).

h. Turn the function switch to the appropriate operating position. Start with the 0-2000 position and then switch to the more sensitive ranges as required to give the best resolution and upscale display.

The analyzer is now operational.

i. Hold the probe so that the nozzle is at the point where the measurement is to be made.

The instrument measures the concentration by drawing the gas in at the end of the nozzle, passing it through an ionization chamber, and discharging the gas at the end of the probe opposite from the tip.

CAUTION

The probe will draw samples from low pressure areas, i.e., from ductwork, or from any distance, and will draw in water.

DO NOT IMMERSE NOZZLE IN LIQUIDS!!
DO NOT IMMERSE NOZZLE IN DIRT, AS FRITTED FILTER WILL CLOG!

WARNING

A high reading should be cause for protective action since the instrument measures gases in the vicinity of the operator.

Take the reading or readings as desired being aware that air currents or drafts in the vicinity of the probe tip may cause fluctuations, and a stable reading may not be possible under these conditions. Change the function switch scale ranges as required.

Samples may be drawn from some distance ~~as the pump is somewhat~~ powerful.

WARNING

Do not dead head the pump as the vacuum in the ion chamber will change affecting an accurate reading.

j. When not conducting measurements and when analyzer is to be kept in readiness state, turn function switch to OFF position.

k. Check battery condition as required by turning the function switch to BATT position. Normal operating time between recharging is 8 to 10 hours. If the Low Battery Indicator comes on, turn analyzer off and recharge.

CAUTION

Use only in an emergency with a low battery when on battery charge. See para. 4.2.

l. After completion of each operating period turn function switch to OFF position, and recharge battery.

m. When not operating, leave analyzer in assembled condition, and connected to battery charger.

n. When transporting, disassemble probe readout assembly. Protect nozzle from dust and dirt.

2-4 SPECIAL PRECAUTIONS

2-4.1 ELECTROMAGNETIC RADIATION

The analyzer is well protected against interference from electromagnetic radiation so no errors normally occur from such sources, such as large electric motors, transformers, switching stations, electromagnets, etc. In an extreme case very close to a highly radiating source, the possibility of such an effect can be determined and corrected by the following procedure. Zero the analyzer in an electrically quiet area with the function switch in the STANDBY position. Then move the analyzer to the questionable area with the switch still in the STANDBY position. If AC pick up is occurring, the meter will indicate the magnitude of the error. The measurement in the operating position can then be compensated by subtracting this value.

TABLE 2-1

CONTROLS

Name	Position	Function
Function Switch		Controls the operation of the analyzer
	OFF	All operations OFF
	BATT (Battery check)	Check the condition of the battery. If the needle on the meter is in the green arc, the battery is charged. If the needle is not in the green arc the battery should be recharged. Can be done in any position, best in OFF, see directions on charger.
	STANDBY	All electronics ON, ultraviolet (UV) light source OFF. This position conserves power and extends battery life. This position is used to set the analyzer zero position. (i.e. no UV light, no signal.)
	0-2000	Sets range of meter at 0-2000 ppm.
	0-200	Sets range of meter at 0-200 ppm.
	0-20	Sets range of meter at 0-20 ppm.
Probe LED Bar Graph Display		Provides relative indication of meter reading (concentration).Each LED of the Bar-graph Display represents 10% of the full scale setting of the range switch.
ZERO		With the function switch in STANDBY position, this control is used to adjust the analyzer to read zero.

Name	Position	Function
SPAN		This control is used to set the sensitivity of the amplifier to make the meter give direct readings of the trace gas concentrations in ppm.
		This control is a vernier control. The whole number of the setting appears in the window of the control, decimal parts appear on the dial. A lock on the control secures it in a specific setting.
HI-VOLTAGE INTERLOCK	---	This is a normally open push button switch.
	Open	Switch is open when cable not connected, causing high voltage for the UV lamp to be disconnected from the 12 pin connector for the probe as a safety precaution.
	Closed	Switch is closed when the probe cable is connected to the readout panel. This connects high voltage to the socket. This switch is automatically closed when the cable is attached by the pressure of the cable connector on the switch push button. This switch may also be closed manually during maintenance checks of the readout assembly without the probe cable attached.

NOTE: See Figure 2-1 for locations

TABLE 2-2

INDICATORS/CONNECTORS

Name	Function
Low Battery indicator (LED)	Illuminates after approximately 10 hours. Do not attempt to take readings when this light is on.
Probe Connector	12 pin connector for cable between the readout assembly and the probe.
Meter/ Probe L.E.D.	Indicates concentration of measured gas.

NOTE: See Figure 2-1 for location.

CHAPTER 3

FUNCTIONAL DESCRIPTION

3-1 PRINCIPLE OF OPERATION

The analyzer measures the concentration of trace gases present in the atmosphere by using the principle of photoioization. Photoionization occurs when an atom or molecule absorbs light of sufficient energy to cause an electron to leave and create a positive ion. This will occur when the ionization potential of the molecule is less than the energy of the photon. The ionization potential of a molecule is that energy in electron volts (eV) required to free an electron. In the [illegible] source of photons is an ultraviolet lamp with an energy of 10.2 eV.

The detection process in this analyzer is shown in Fig. 3-1. Sample gases enter through the nozzle into the ion chamber. The ultraviolet lamp generates photons with an energy of 10.2 eV and these enter the ion chamber. Ionization occurs for those molecules having ionization potentials less than 10.2 eV.

A positive biased electrode causes these positive ions to travel to a collector in the chamber. Here ions create a current proportional to concentration at the collector which is then amplified and the signal displayed on the meter.

The amount of ionization occuring, and thus the input signal to the amplifier, is proportional to the amount of trace gas present in the ion chamber and to the ionization sensitivity of that gas.

Gases that will be ionized are those with ionization potentials of 10.2 eV or less. Typical gases that will be ionized and their potentials are listed in Table 3-1. These gases will thus be detected and measured with this analyzer.

The ion chamber is kept at reduced pressure to minimize effects of humidity and other gases:

Gases having ionization potentials higher than approximately 10.2 eV will not be ionized by this analyzer. Examples of th#se and their potentials are listed in Table 3-2. As can be seen from the table the ionization potential of the major components of air, i.e., oxygen, nitrogen, carbon dioxide, and of methane and freons, range from about 12.0 eV to about 15.6 eV and will thus not be ionized by photons from the 10.2 eV lamp.

When the analyzer is used to measure a mixture of gases, such as hydrocarbons in air, a calibration gas is selected to approximate the average response of the components to be measured. In this case, isobutylene is the compound whose response best approximates these hydrocarbons.

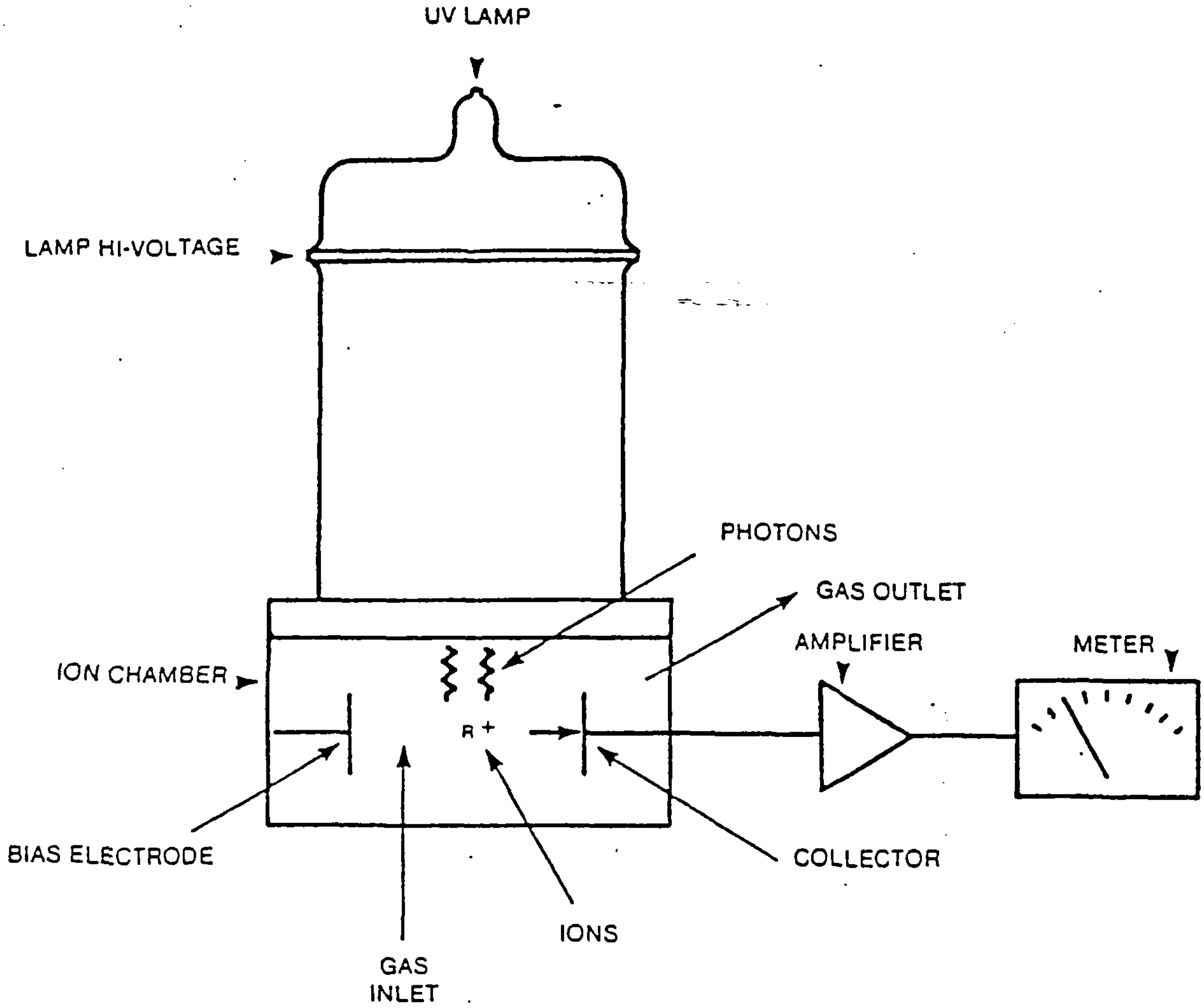


FIGURE 3-1
DETECTION PROCESS

TABLE 3-1

TYPICAL GASES THAT WILL BE IONIZED BY THE ANALYZER

Gas	Ionization Potential (eV)
Xylene	8.56
Toluene	8.82
Cyclohexanone	9.14
Benzene	9.25
Isobutylene	9.44
Trichloroethylene	9.45
Methyl ethyl ketone	9.53
Tetrahydrofuran	9.54
Acetone	9.69
Vinyl chloride	10.00
Ammonia	10.15
Isopropanol	10.17
Hexane	10.18
Ethanol	10.48

TABLE 3-2

TYPICAL GASES THAT WILL NOT BE IONIZED BY THE ANALYZER

Gas	Ionization Potential (eV)
Methanol	10.85
Nitromethane	11.08
Methyl chloride	11.28
Chlorine (C12)	11.48
Methyl chloroform	11.5
Freon 11	11.77
Freon 113	11.78
Genetron (101)	11.98
Freon 114	approx. 12
Oxygen (02)	12.1
Acetonitrile	12.22
Freon 12	12.31
Freon 13	12.91
Methane (CH4)	12.98
Carbon dioxide (C02)	13.79
Carbon monoxide (CO)	14.01
Hydrogen	15.426
Nitrogen (N2)	15.6

3-2 EQUIPMENT DESCRIPTION

The components of the analyzer are located in the probe and the readout assembly (see Fig. 3-2 and 3-3). The ion chamber, UV light source, amplifier board, pump and filter nozzle are located in the probe assembly. The battery, the power supply board, and the meter are located in the readout assembly. The probe and the readout assembly are connected by an 800 cm (32") cable.

The pump draws gas in through the filter and orifice located in the filter nozzle, through the ion chamber, and then discharges it through the hollow exhaust screw in the handle. The flow rate is approximately 175 to 275 cubic centimeters per minute. A general variation in the flow rate will not affect the measurement. A major obstruction to the flow, however, will prevent proper readings and lengthen response time, by changing the vacuum in ion chamber.

The output signal from the ion chamber goes to the amplifier and through the cable to the meter on the readout assembly.

Voltage for the light source, ion chamber, amplifier and pump is provided from a DC converter on the power supply board. The battery provides the source of power for the converter. The positive side of the battery is grounded.

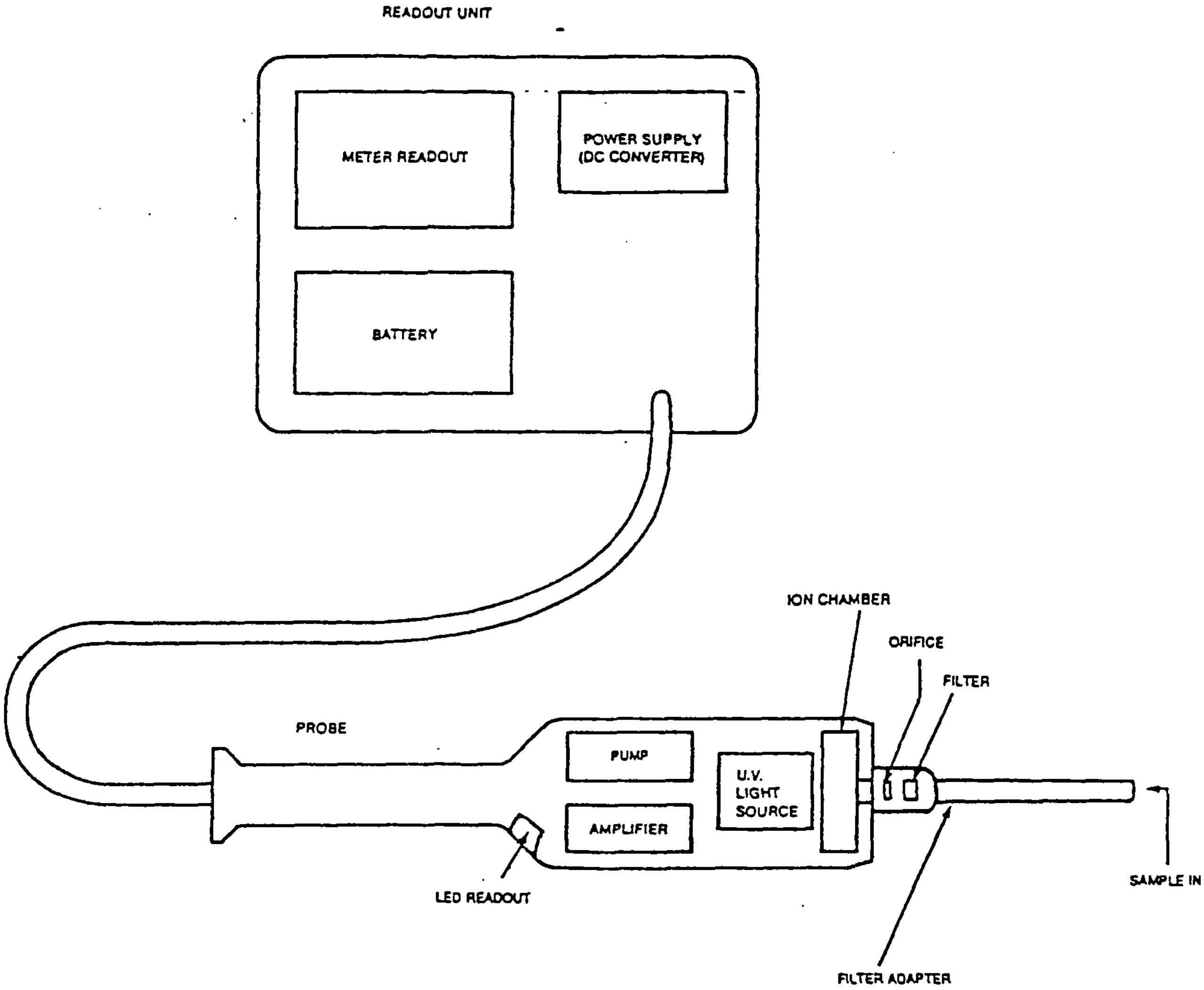
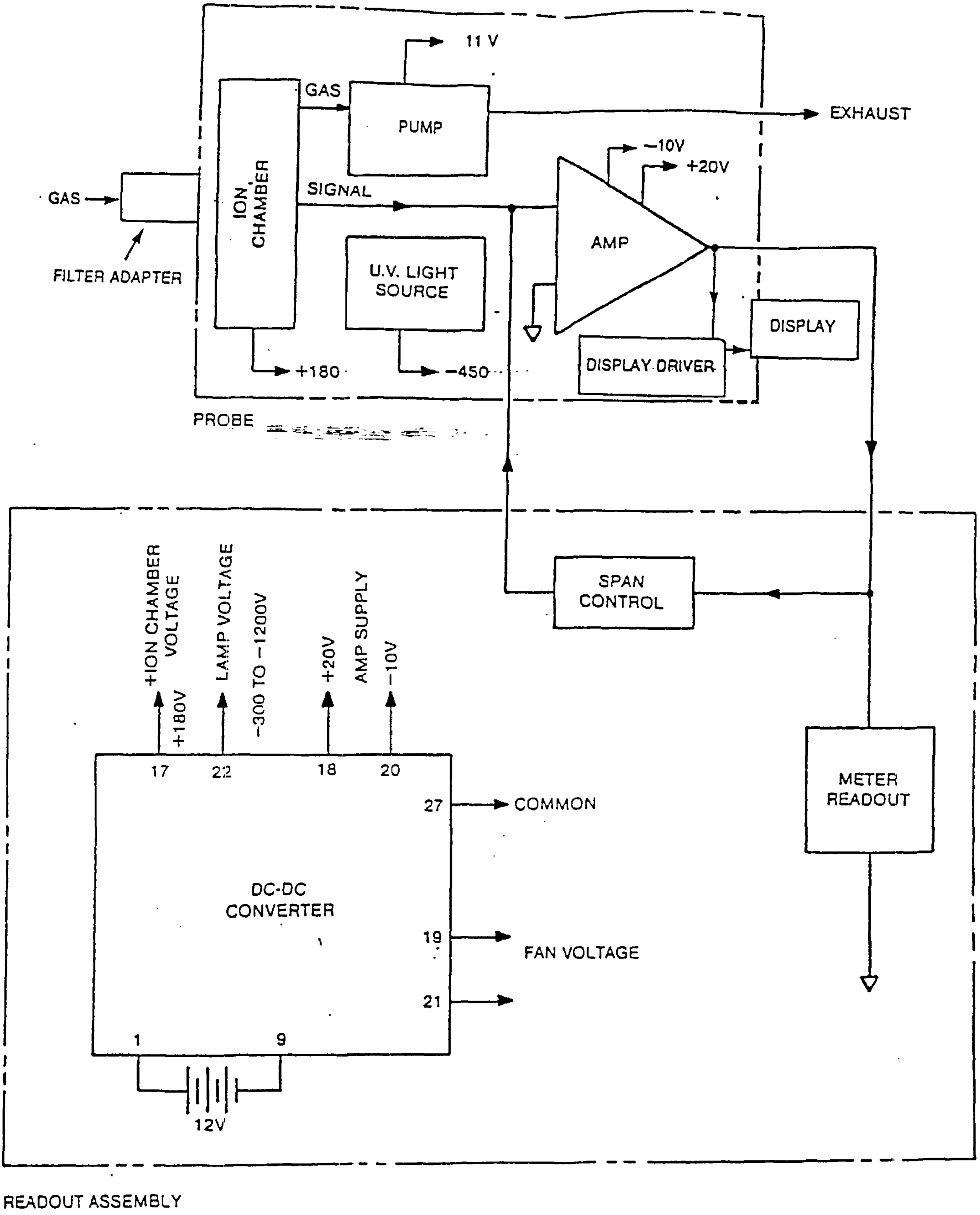


FIGURE 3-2
BLOCK DIAGRAM
COMPONENT LOCATION



NOTE: ALL VOLTAGES SHOWN ARE NOMINAL VALUES.

FIGURE 3-3
BLOCK DIAGRAM
ELECTRICAL CONNECTIONS

CHAPTER 4

SCHEDULED MAINTENANCE

4-1 INTRODUCTION

Scheduled maintenance actions for the analyzer are those listed in Table 4-1.

4-2 BATTERY CHARGE

Check the battery charge as described in paragraph 2-3g. If the battery is low as indicated by the meter reading or the warning indicator LED, it is necessary to recharge the battery.

To charge the battery, first insert the mini phone plug of the charger into the jack, J6, on the side of the bezel adjacent to the meter. Then insert the charger plug into a 120 VAC single phase, 50-60 cycle outlet. To ensure that the charger is functioning, turn the function switch, S1, to the battery check (BATT position. The meter should deflect full scale if the charger is working, leave the function switch in the OFF position.

The analyzer can be operated, however, while charging by turning the function switch to the desired position. Such usage will extend the time required to completely recharge the battery. A normal full recharge of the battery from low voltage level as indicated by the warning light takes about 6 hours.

4-3 UV LAMP AND ION CHAMBER

During periods of operation of the analyzer, moisture or other foreign matter could be drawn into the probe forming deposits on the surface of the UV lamp or in the ion chamber. These deposits would interfere with the ionization process and cause erroneous readings. Cleaning can be accomplished as follows:

Disassemble the probe as described in Paragraph 6-2.1

<u>WARNING</u>

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise, high voltage of 1200 VDC will be present.

First, clean the lamp with a mild detergent and wipe dry. Then, the ion chamber can be inspected for dust or particulate deposits. If such matter is present, the assembly can be gently swirled in ethanol or isopropanol and dried gently at 50 - 60 degrees C for approximately a half hour. No liquid must be present at reassembly as this would affect the performance.

Reassemble the probe as described in paragraph 6-2.1 and check calibration of the analyzer (see Section 4-4).

If the calibration is still not satisfactory, disassemble the probe again and clean the lamp with the special HNU cleaning compound (see Table 1-3). As this is a rigorous cleaning procedure it should be done only after the more gentle cleaning is tried as described above. Do not clean the ion chamber with this special cleaning compound. Do not clean 11.7 ev lamps with this compound; a special cleaning compound is available for 11.7 lamps.

Reassemble the probe, check to see if the lamp is on before reattaching the filter nozzle (see WARNING, Section 2-3j), and calibrate the analyzer (see Section 4-4).

4-4 CALIBRATION

The analyzer is calibrated by use of a cylinder and a regulator (see Table 1-3). The cylinder contains a calibration gas consisting of a mixture of isobutylene in zero air. Isobutylene is non-toxic and safe to use in confined areas. There are no listed exposure levels at any concentration.

The regulator sets and controls the flow rate of gas to the analyzer at a value preset at the factory.

The analyzer is connected to the output of the regulator with a short piece (butt connected) of flexible tubing (see Figure 4-1). It is important to use clean tubing since contaminated tubing will adversely affect the calibration readings.

Set the function switch on the analyzer at the desired ppm range position. The gas from the regulator will flow thru the probe. The isobutylene level in the calibration gas is specifically selected for the analyzer. The desired ppm level to be indicated on the meter is given on the cylinder label.

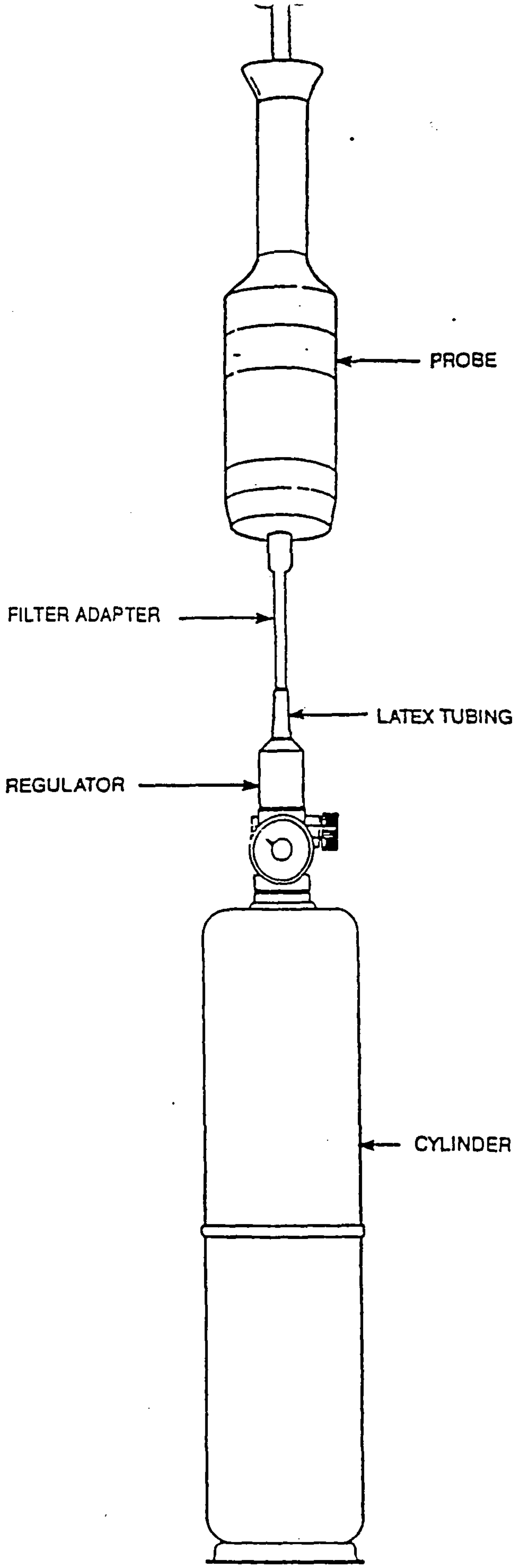


FIGURE 4-1
CALIBRATION TEST SET UP

Adjust the span control so the meter reads the specified value. Turn the function switch back to the STANDBY position. Check and reset the zero setting if necessary. If this setting is changed, recheck the calibration setting.

NOTE: To conserve calibration gas, this cylinder should be opened until a steady reading is secured and any adjustment is made (1 min.). This is the most effecient use of the calibration gas cylinder. Do not use the cylinder below about 30 PSIG as the reading can deviate up to 10% from the rated value. Safely discard the disposable cylinder when empty. If questions arise about disposal, this cylinder contained 99.99% pure air with 100ppm Isobutylene (non-toxic, non-flammable impurity).

If the span setting resulting from calibration is 0.0 or if the calibration cannot be achieved then the lamp must be cleaned (see Section 4-3 and 6-2.1).

If the analyzer still cannot be calibrated (the lamp may be ON but the output too low) or if the lamp has failed it must be replaced.

To replace the lamp, disassemble the probe, remove the old lamp, install a new one and reassemble. Set the SPAN pot to 8.0. Remove the readout assembly case (see Section 6-2.2). Locate the gain control potentiometer, R48, on the power supply board as shown on Figure 5-2. Recalibrate the analyzer adjusting this potentiometer, R48, with a small screwdriver to obtain the specified ppm reading.

If the analyzer still cannot be calibrated, it is possible that it may be leaking. The HW 101 normally operates at approximately 775 mbars +/- 30 mbars, and if not reassembled properly can leak.

NOTES:

1) The screws holding the end cap are special screws with rubber gaskets in the head.

2) The ion chamber has a special gasket on the screen retainer.

3) The filter nozzle must have its gasket in place where it connects with the probe. (The filter nozzle should not be disassembled either for filter replacement or general cleaning)

WARNING

Use great care when operating the analyzer with readout assembly outside the case due to the presence of -1200 V DC.

When calibration is accomplished, turn the analyzer OFF and replace the readout assembly in its case.

Adjustment of R48 potentiometer is used only when a new lamp is installed. At all other times adjustment is accomplished using the SPAN control potentiometer.

TABLE 4-1

SCHEDULED MAINTENANCE ACTION INDEX

Periodicity	Maintenance Action	Reference para.
As required	Battery recharge	4-2
Monthly (or as required)	UV Lamp and Ion Chamber	4-3
Daily	Calibration	4-4

CHAPTER 5

TROUBLESHOOTING

5.1 INTRODUCTION

The initial step of any troubleshooting is a thorough visual inspection to look for possible loose or open connections, shorts, dust or other obvious conditions.

Detailed troubleshooting for fault location and correction is accomplished by steps outlined in the following.

Fault Logic Diagram	Figure 5-1
Test Points, Power Supply PCB	Figure 5-2
Troubleshooting Data	Table 5-1
Troubleshooting Index	Table 5-2
Fuse Index	Table 5-3
Indicator Lamp Index	Table 5-4
Relay Index	Table 5-5
Pad Data, Power Supply PCB	Table 5-6
Pin Data, Amplifier PCB, P2/J2	Table 5-7
Pin Data, Probe Cable, P3/J3	Table 5-8

Disassembly and reassembly as may be required for checking the equipment or replacing parts are described in Chapter 6.

WARNING

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise high voltage of -1200 VDC will be present.

WARNING

Do not observe the light source closer than 6 inches. When necessary, observe only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight

WARNING

When conducting tests on analyzer in open condition, exercise great care due to presence of high voltage.

TABLE 5-1

TROUBLESHOOTING DATA

Symptom	Probable Cause	Corrective Action
1. Meter indicates low battery	a. Battery charge low	1) Recharge battery, check meter with function switch in BATT position to ensure the charger is operating properly (See Table 2-1)
	b. Battery dead	1) Disconnect battery and check with voltohmeter. Should read -11 to -15 V DC. Replace if dead. (See Section 6-2.2)
	c. Blown fuse (F1,2A,Fig.3-3)	1) Check fuse. If blown, check low battery for evidence of shorts in wiring, then replace fuse.
	d. Bad connections	1) Check wiring connections. Repair poor or bad connections.
	e. Broken meter movement	1) Tip instrument rapidly from side to side. Meter needle should move freely, and return to zero. If faulty, replace with new meter.
2. Low battery	a. Power supply defective.	1) Check power supply voltages (see Figure 5-2 and Table 5-6). If in error replace control assembly.

3. UV Lamp not ON	a. High Voltage interlock (Microswitch S2) at probe cable connector on readout assy not operating	1) Check by applying pressure to switch plunger with cable in place. Adjust hex screw on side of cable connector, if required to increase throw of switch plunger.
	b. High voltage supply out or faulty.	1) Check high voltage output on power supply board (pad 22). If voltage not correct (See Table 5-3) replace control assembly.
	c. Lamp not making proper connection with high voltage	1) Remove lamp, clean and tighten contacts, re-install lamp.
	d. Lamp faulty	1) Replace lamp.
	e. Short in high voltage lines.	1) Check wiring from power supply board to probe cable connector (J3 pin D) to UV lamp contacts (D1). Remove any shorts.
4. Pump not running	a. Pump stuck	1) Disassemble probe and clean passages with care.
	b. Pump connections faulty	1) Check for wiring connections at pump motor and at probe cable connector. Repair as required.
	c. Low or dead battery	1) Check battery output (power supply board,pad 8) Recharge or replace battery as required.
	d. Pump voltage not correct	1) Check pump voltage (power supply board pads 19 and 21, probe cable pins A and C). If not correct, replace control assembly.

Symptom	Probable Cause	Corrective Action
		2) If pump voltages correct, replace pump.
5. Meter does not respond.	a. Dirty or open probe connection.	1) Clean and tighten or resolder connections in probe.
	b. Broken meter movement.	1) See 1-e-1 above.
	c. Dirty or open connections to meter	1) Clean and tighten connections at meter.
	d. Low or dead battery	1) See 4-c-1 above.
	e. Blown fuse	1) See 1-a-1 above.
6. Meter does not return to zero in STANDBY	a. Broken meter movement	1) See 1-e-1 above.
	b. Dirty or open connections to meter	1) See 5-c-1 above.
	c. Dirty or open connections in probe.	1) See 5-a-1 above.
	d. Zero adjust faulty	1) Rotate zero adjust pot (see Fig. 2-1) (R50, Fig. 3-4). Check pot output at meter probe connector (J3 pins B and L). If voltage does not vary, replace zero adjust pot.
	e. Amplifier faulty	1) Rotate zero adjust pot.Check amplifier output at power supply PCB (Pad 11), amplifier board connector (P2/J2 pin E), or probe connector (P3/J3 pin E), or observe meter. If voltage level on meter does not respond, replace amplifier board.

Symptom	Probable Cause	Corrective Action
	f. Ion chamber shorted	1) Clean ion chamber. (See para. 4-3) Recheck analyzer operation in returning to zero at STANDBY. 2) Replace ion chamber.
7. Meter readings high or low.	a. Incorrect calibration	1) Recalibrate (see para 4-4).
	b. Lamp dirty.	1) Clean lamp (see para 4-3).
	c. Contamination in ion chamber.	1) Clean ion chamber (see para. 4-3).
	d. 0 ring leaking or missing	1) Check 0 rings and adjacent surfaces (see para. 6-2.1).
	e. Power supply board faulty.	1) Check power supply board outputs. (pads 17, 20, and 22 Table 5-3). If voltages not correct, replace control assembly.
	f. Dirty or loose connections.	1) Clean or tighten connections at amplifier board, probe cable, and meter.
	g. Probe may be leaking	1) Place finger over filter nozzle inlet and check flow at the exhaust. There should be no flow. 2) Remove filter nozzle and place finger over inlet and recheck flow at exhaust. There should be no flow. 3) If still leaking, remove end cap and ion chamber and block inlet to pump at small "O" ring on retainer. There should be no flow. If still leaking at this point, call HNU Service Department.

Symptom	Probable Cause	Corrective Action
8. Meter erratic, unstable or non-repeatable	a. Loose cable connection	1) Check cable connection at control panel. Observe meter. Tighten cable as required.
	b. Dirty or loose meter connections	1) Check meter connections. Clean and tighten as required.
	c. Contamination in ion chamber.	1) Clean ion chamber. (see para. 4-3).
	d. Power supply board	1) See 7-D-1 above.
	e. Unstable or noisy	1) Observe lamp (Important see Warning, Section 2-3j). If operation not steady, replace lamp.
	f. Function switch in high gain, most sensitive position (i.e., 0-20ppm)	1) Unstable meter operation is common with function switch in most sensitive position. Turn switch to less sensitive position if desirable.
	g. Pump not operating properly.	1) See 7G
	h. Gas flow slow or	1) See 4-a-1 above.
	i. Meter contacts dirty or loose.	1) Clean and tighten contacts
	j. Electromagnetic interference	1) See 2-4.2
	h. Hi Voltage Interblock	1) See 3-A-1
9. Drifting meter readings	a. Ion Chamber contaminated.	1) Clean ion chamber. (See para. 4-3)
10. LED Readout on probe	a. Out completely Meter OK	
	b. Some segments out	

TABLE 5-2

TROUBLESHOOTING INDEX

Functional Area	Troubleshooting alignment / adjustment (Table 5-2 Para.)	Diagram (Fig. No.)	Functional Description (Para.)
Battery	1,4,5	3-4	3-2
Controls/Circuitry	5,6,7,8,9	3-4	3-2
Meter	1,5,6,7,8	3-4	3-2
Power Supply	2,3,4,7,8	3-4	3-2
Pump	4,8	3-4	3-2
Lamp	3,7,8	3-4	3-2
Ion Chamber	6,7,8	3-4	3-1,3-2
Filter Nozzle			
LED Readout			

TABLE 5-3

PAD DATA, POWER SUPPLY PCB

Pad No.	Signal Name	Voltage (Vdc)
1	Battery Positive(+)	0
2	Ground	0
3	Battery Charger (+)	0
4	Low Battery Indicator	
5	Low Battery Indicator	
6	Hi-Volt Relay Disconnect -Pump Ground	-12(See Note)
7	Battery Charger (-)	-11 to - 15
8	Battery negative (-)	-11 to - 15
9	Battery negative (-)	-11 to - 15
10	Hi-Volt relay disconnect	0 or -12
11	Amplifier Signal	0 to -5
12	Signal divider for span control	0 to -5
13	" " " " "	"
14	" " " " "	"
15	" " " " "	"
16	" " " " "	"
17	Ion chamber accelerating voltage	+180
18	Zero adjust voltage power	+18 to +21
19	Not Used	
20	Amplifier Power	-9.5 to10.5
21	Pump Power	-10.nominal (see NOTE)
22	UV Lamp	up to -1200 (see para32)
23	Output Signal to Meter	0 to -5
24	Battery Check Voltage	-11 to -15
25	Not Used	
26	Signal Feedback	0 to -5
27	Ground	0
28	Ground	0
29	Not Used	
30	Ground	0
31	Ground	0

NOTE: Differential voltage for pump between pads 21(+) and 6(-) will be between 9.0 and 11.0 volts DC.

TABLE 5-4

PIN DATA, AMPLIFIER PCB, P2/J2

Pin #	Signal Name	Voltage (V DC)
A	Ground	0
B	Span Control Setting	varying
C	Zero Adjust	varying
D	Amplifier Power	-9.5 to -10.5
E	Amplifier Signal	0 to -15.0
F	Zero Adjust Voltage	+18 to +21
3	Zero Adjust	varying

TABLE 5-5

PIN DATA, PROBE CABLE, P3/J3

Pin #	Signal Name	Voltage (V DC)
A	Pump Ground	-12 nominal
B	Zero Adjust	varying
C	Pump Power	-1.0 nominal
D	UV Lamp	up to -1200 (see para. 3-2)
E	Amplifier Signal	0 to -5.0
F	Ground	0
H	Span Control Setting	varying
J	Ground	0
K	Zero adjust Voltage	+18 to +21
L	Zero Adjust	varying
M	Ion Chamber accelerating voltage	+180
N	Amplifier Power	-9.5 to -10.5

NOTE: Differential potential for pump between pins C(+) and A(-) will be between 9.0 and 11.0 Volts DC.

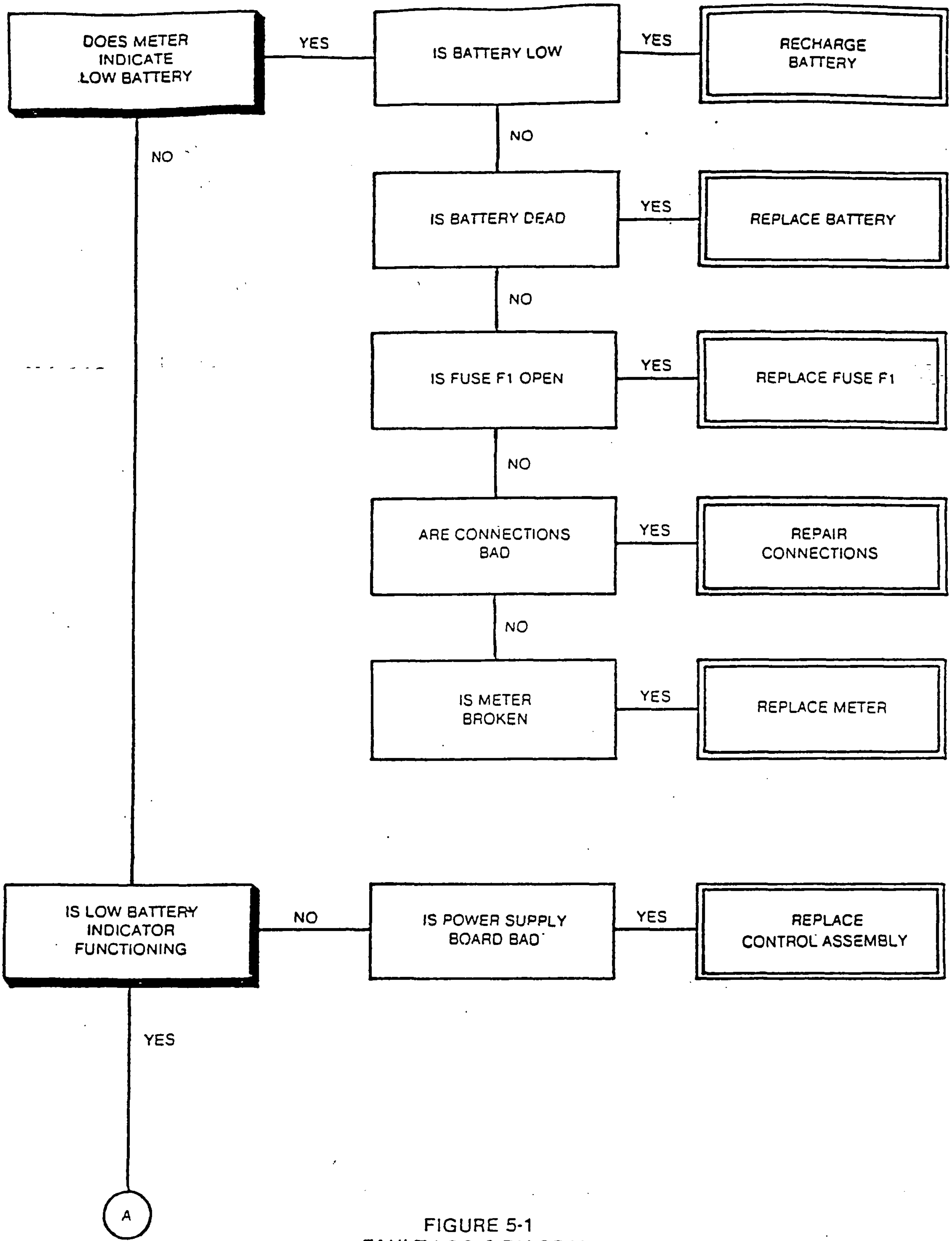
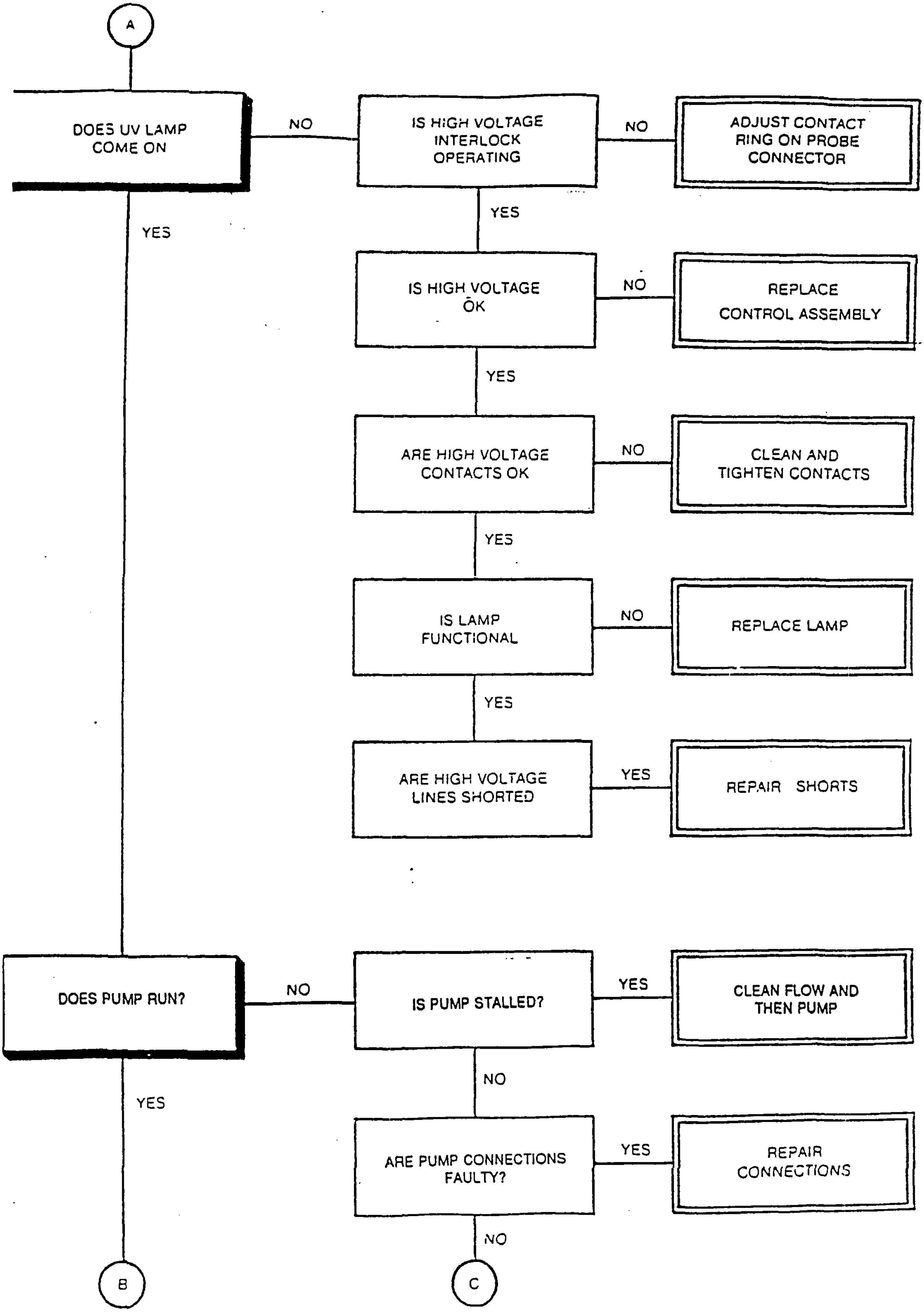
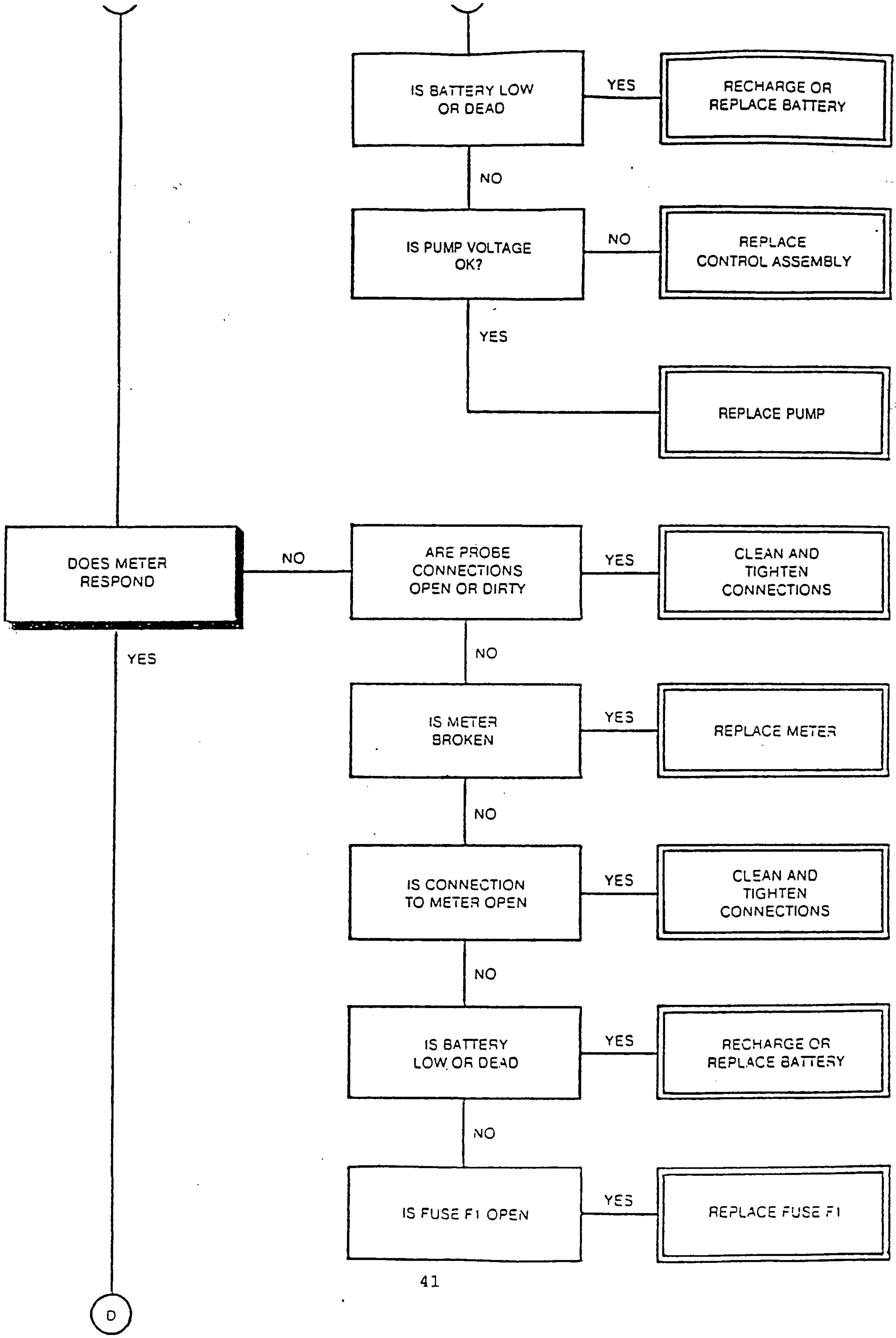
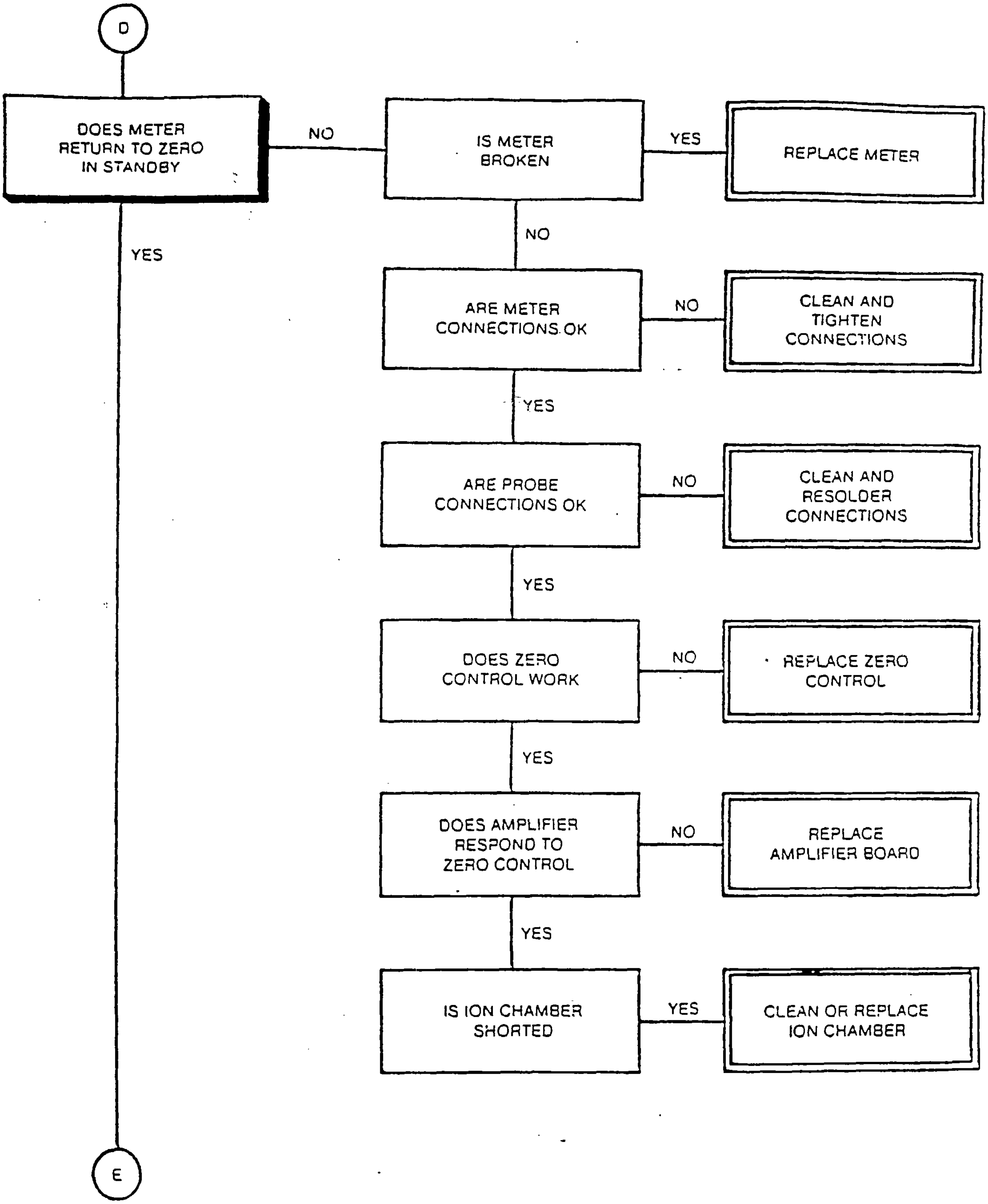
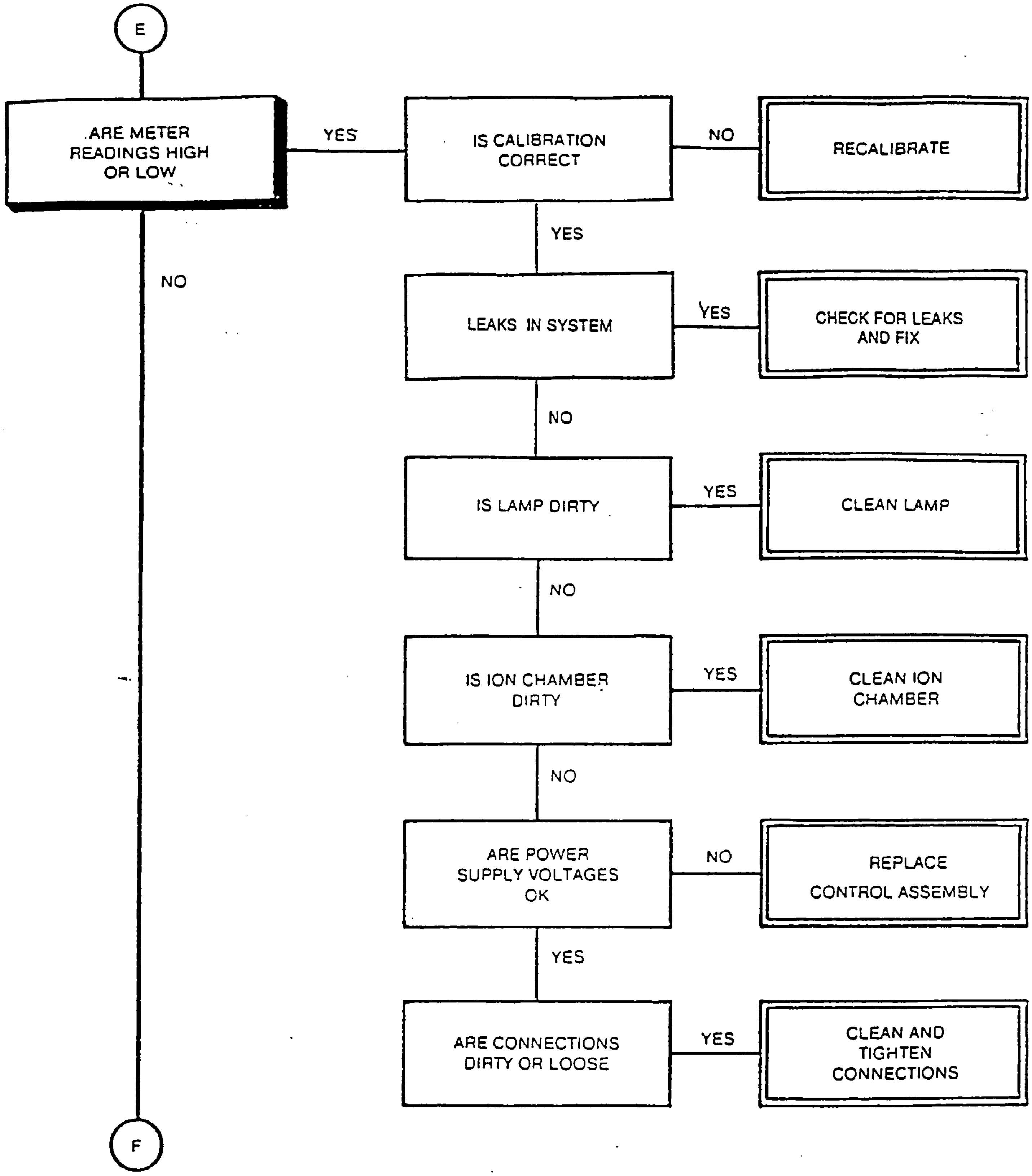


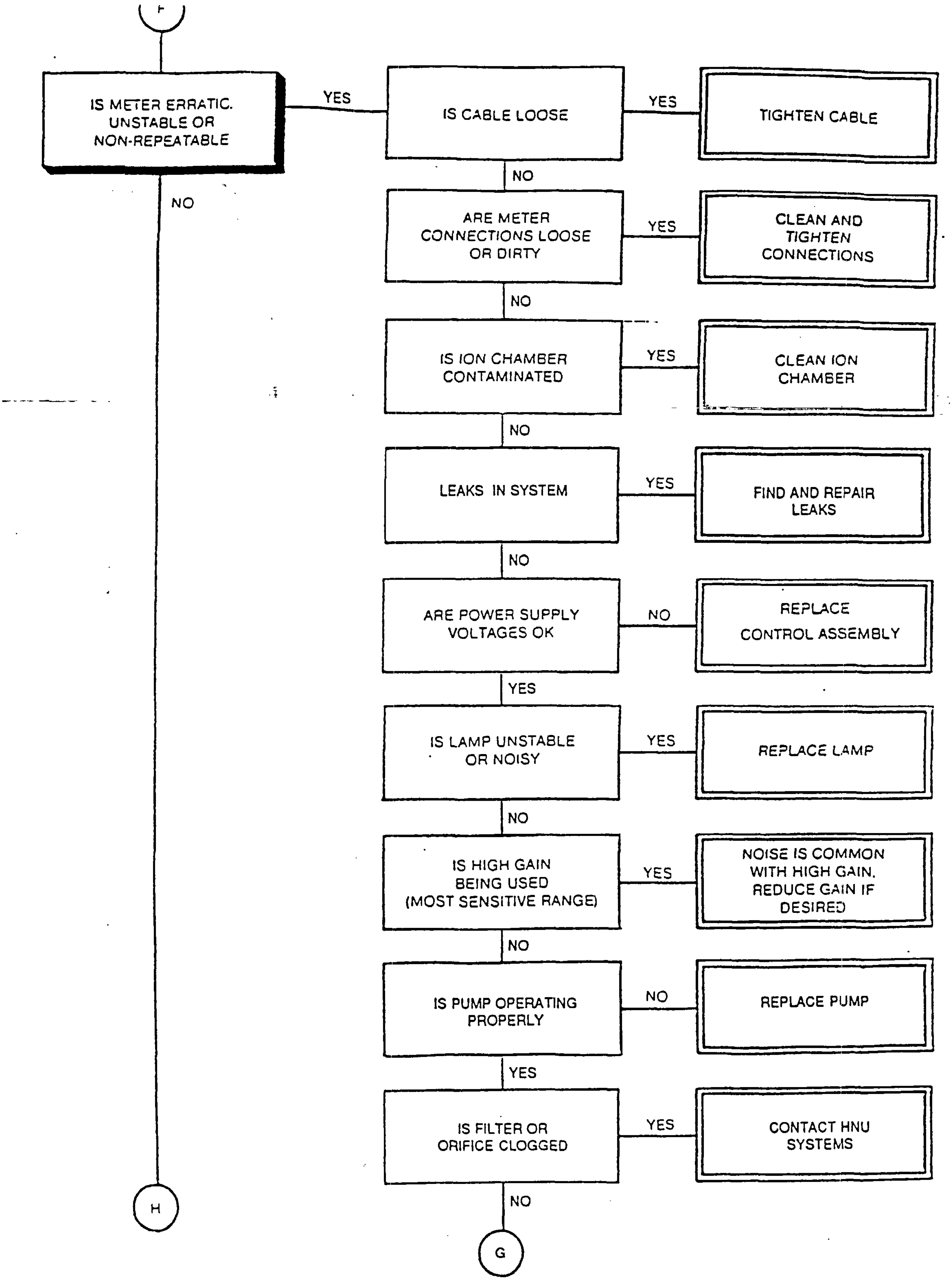
FIGURE 5-1
FAULT LOGIC DIAGRAM

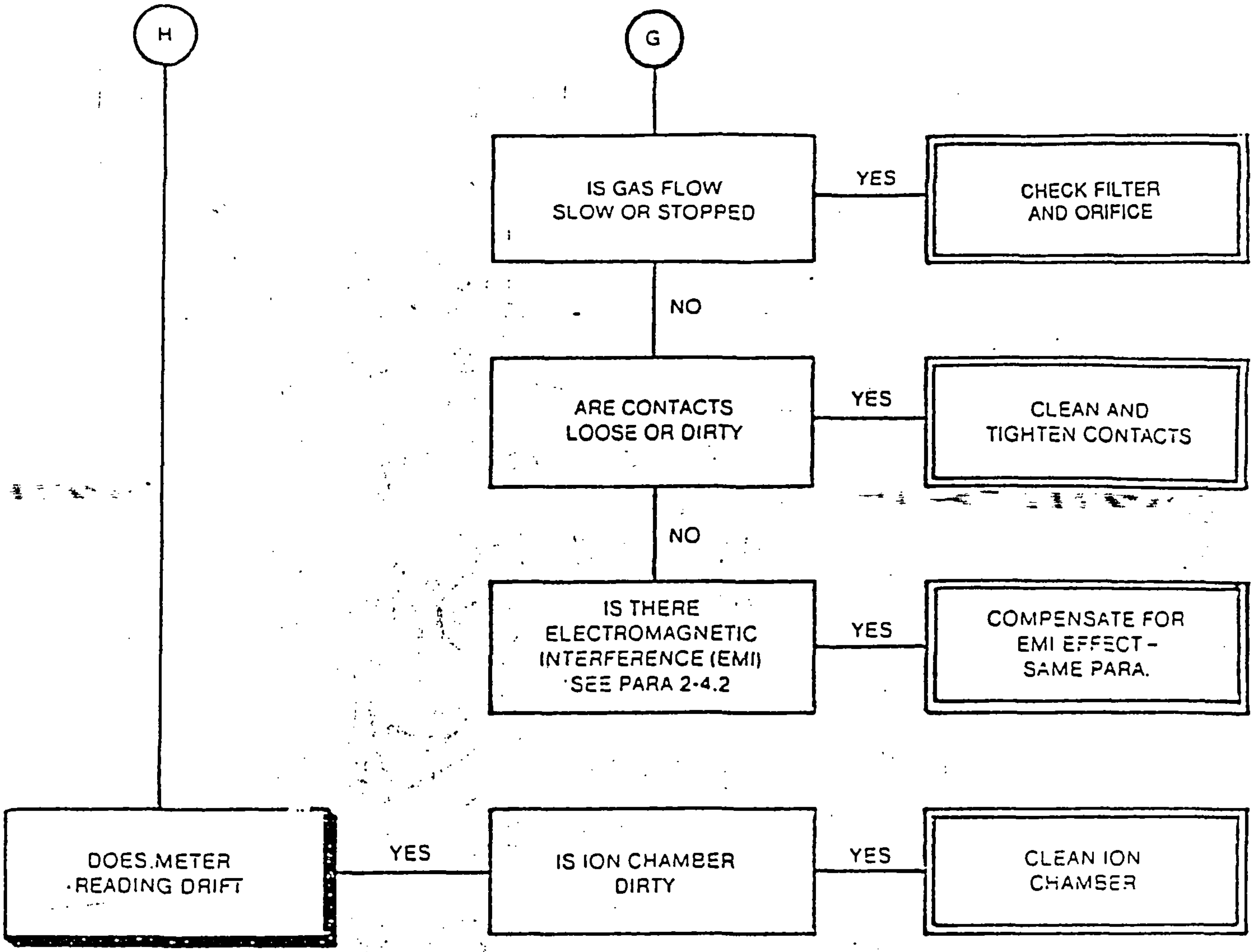

A
DOES UV LAMP COME ON
NO
IS HIGH VOLTAGE INTERLOCK OPERATING
NO
ADJUST CONTACT RING ON PROBE CONNECTOR
YES
YES
IS HIGH VOLTAGE OK
NO
REPLACE CONTROL ASSEMBLY
YES
ARE HIGH VOLTAGE CONTACTS OK
NO
CLEAN AND TIGHTEN CONTACTS
YES
IS LAMP FUNCTIONAL
NO
REPLACE LAMP
YES
ARE HIGH VOLTAGE LINES SHORTED
YES
REPAIR SHORTS
DOES PUMP RUN?
NO
IS PUMP STALLED?
YES
CLEAN FLOW AND THEN PUMP
NO
YES
ARE PUMP CONNECTIONS FAULTY?
YES
REPAIR CONNECTIONS
NO
B
C


IS BATTERY LOW OR DEAD
YES
RECHARGE OR REPLACE BATTERY
NO
IS PUMP VOLTAGE OK?
NO
REPLACE CONTROL ASSEMBLY
YES
REPLACE PUMP
DOES METER RESPOND
NO
ARE PROBE CONNECTIONS OPEN OR DIRTY
YES
CLEAN AND TIGHTEN CONNECTIONS
NO
IS METER BROKEN
YES
REPLACE METER
NO
IS CONNECTION TO METER OPEN
YES
CLEAN AND TIGHTEN CONNECTIONS
NO
IS BATTERY LOW OR DEAD
YES
RECHARGE OR REPLACE BATTERY
NO
IS FUSE F1 OPEN
YES
REPLACE FUSE F1
YES
D


D
DOES METER RETURN TO ZERO IN STANDBY
NO
IS METER BROKEN
YES
REPLACE METER
NO
ARE METER CONNECTIONS OK
NO
CLEAN AND TIGHTEN CONNECTIONS
YES
ARE PROBE CONNECTIONS OK
NO
CLEAN AND RESOLDER CONNECTIONS
YES
DOES ZERO CONTROL WORK
NO
REPLACE ZERO CONTROL
YES
DOES AMPLIFIER RESPOND TO ZERO CONTROL
NO
REPLACE AMPLIFIER BOARD
YES
IS ION CHAMBER SHORTED
YES
CLEAN OR REPLACE ION CHAMBER
YES
E


E
ARE METER READINGS HIGH OR LOW
YES
IS CALIBRATION CORRECT
NO
RECALIBRATE
YES
LEAKS IN SYSTEM
YES
CHECK FOR LEAKS AND FIX
NO
IS LAMP DIRTY
YES
CLEAN LAMP
NO
IS ION CHAMBER DIRTY
YES
CLEAN ION CHAMBER
NO
ARE POWER SUPPLY VOLTAGES OK
NO
REPLACE CONTROL ASSEMBLY
YES
ARE CONNECTIONS DIRTY OR LOOSE
YES
CLEAN AND TIGHTEN CONNECTIONS
NO
F


F
IS METER ERRATIC. UNSTABLE OR NON-REPEATABLE
YES
IS CABLE LOOSE
YES
TIGHTEN CABLE
NO
ARE METER CONNECTIONS LOOSE OR DIRTY
YES
CLEAN AND TIGHTEN CONNECTIONS
NO
IS ION CHAMBER CONTAMINATED
YES
CLEAN ION CHAMBER
NO
LEAKS IN SYSTEM
YES
FIND AND REPAIR LEAKS
NO
ARE POWER SUPPLY VOLTAGES OK
NO
REPLACE CONTROL ASSEMBLY
YES
IS LAMP UNSTABLE OR NOISY
YES
REPLACE LAMP
NO
IS HIGH GAIN BEING USED (MOST SENSITIVE RANGE)
YES
NOISE IS COMMON WITH HIGH GAIN. REDUCE GAIN IF DESIRED
NO
IS PUMP OPERATING PROPERLY
NO
REPLACE PUMP
YES
IS FILTER OR ORIFICE CLOGGED
YES
CONTACT HNU SYSTEMS
NO
G
NO
H



Note: For further details, see Table 5-1.

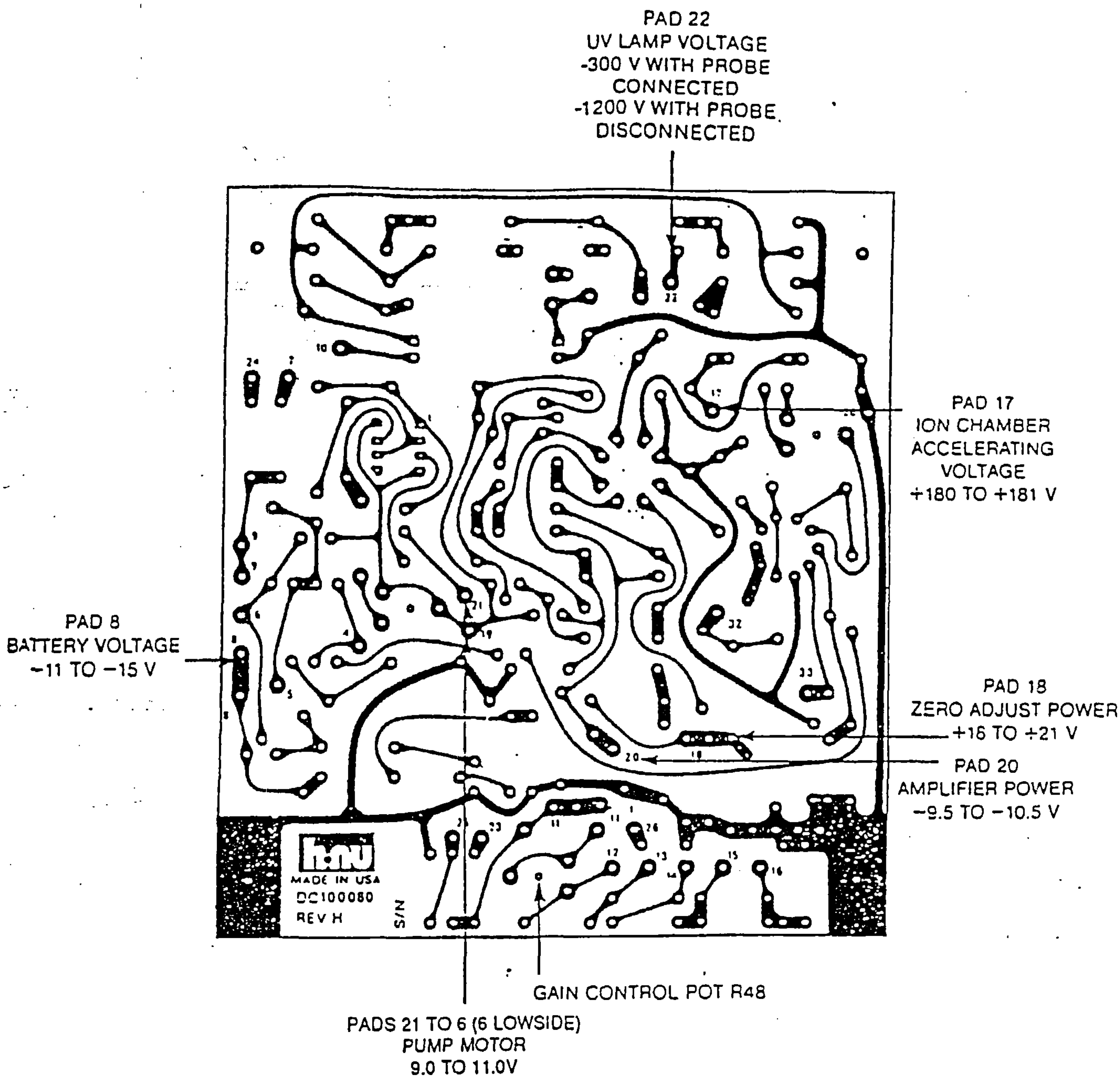


FIGURE 5-2
TEST POINTS
POWER SUPPLY PCB

CHAPTER 6

CORRECTIVE MAINTENANCE

6-1 INTRODUCTION

The scope and function of corrective maintenance of the analyzer consists of the disassembly, replacement of component parts and subassemblies and the reassembly. All adjustments and calibrations are described in chapters 2 through 5.

6-2 EQUIPMENT DISASSMBLY/REASSEMBLY

Disassembly and reassembly of the analyzer for maintenance and part replacement can be accomplished as follows.

6-2.1 PROBE ASSEMBLY

WARNING

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise high voltage of -1200 VDC, will be present.

Disconnect the probe cable connector at the readout assembly.

Hold the lamp housing with the black end cap upright. Loosen the screws on the top of the end cap, separate the end cap and ion chamber from the lamp and lamp housing.

CAUTION

Care must be taken so that the ion chamber does not fall out of the end cap or the light source does not fall out of the lamp housing.

Be sure to retain all "O" rings and gaskets to ensure leak tight reassembly.

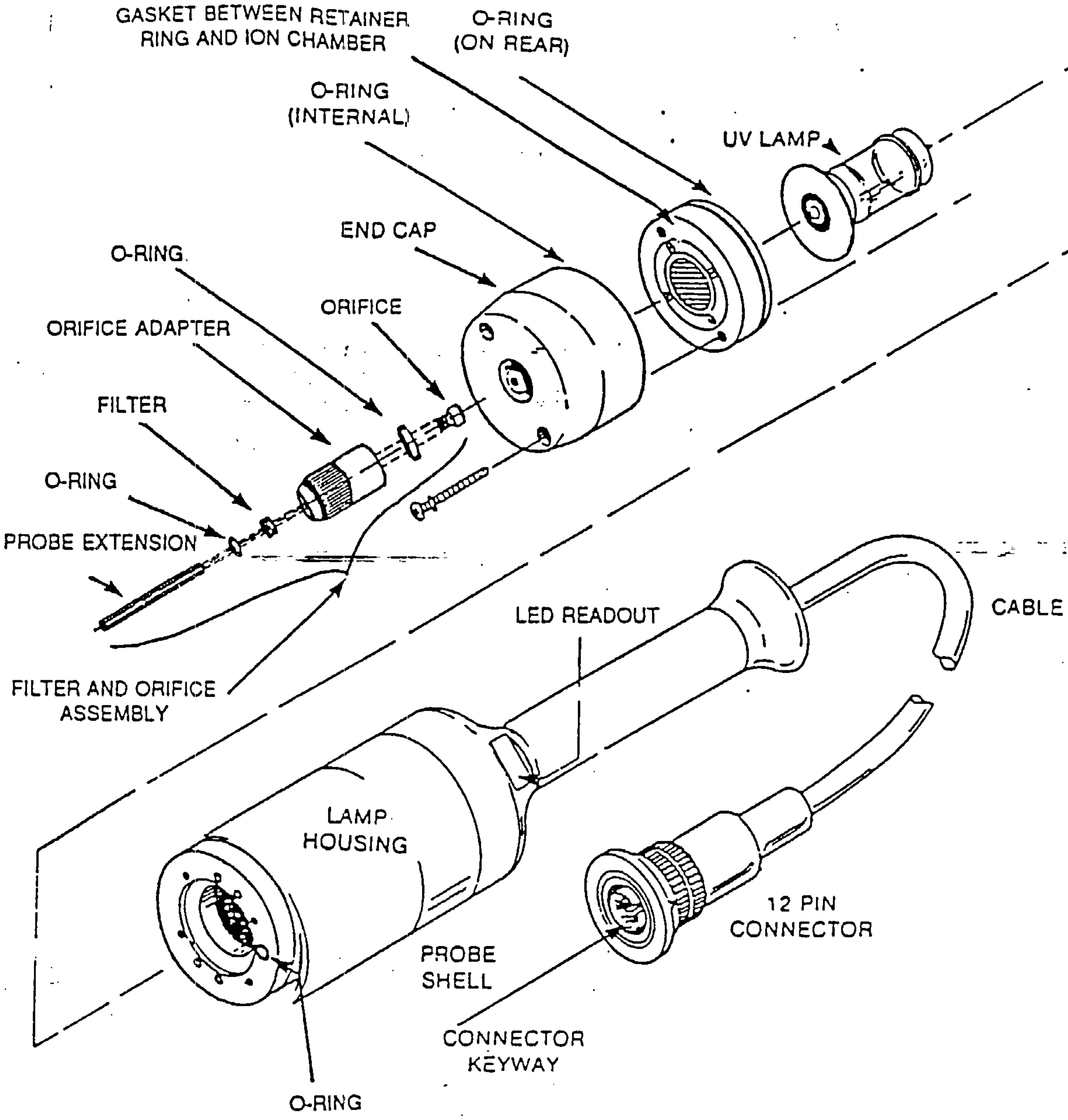


FIGURE 6-1
PROBE ASSEMBLY

Turn the end cap over in the hand. Tap lightly on the top. The ion chamber should fall out of the end cap.

Place one hand over the top of the lamp housing and tilt slightly. The lamp will slide out of the housing.

Clean or replace the lamp as required (see Section 4-3 for lamp cleaning).

Remove any dust or particles that may be deposited in the sample passages by gently blowing, or by lightly brushing with a camels hair brush. Extreme care is required to prevent damage to the pump.

Inspect the surfaces adjacent to the O-rings for evidence of leakage. Replace any O-rings where such evidence appears. A special tool is required to remove the lamp housing from the probe. Contact HNU Systems.

The amplifier board can be removed from the lamp source housing subassembly, (see Fig. 6-2) by unsnapping the coaxial connector, J1, and then removing the retaining screw. The amplifier board will then slide out of the housing assembly.

Reassemble the probe by first sliding the lamp back into the lamp housing. Place the ion chamber on top of the lamp housing, making sure that the contacts are properly aligned, and "O" rings are seated correctly. The ion chamber fits only one way.

Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws enough to seal the O-ring. Check to be sure the assembly is leak tight by blocking the sample inlet and checking for no-flow at the exhaust.

CAUTION

Check ion chamber alignment. It only fits one way.

Align the 12 pin probe connector to the readout assembly and reconnect with a twisting motion until a click occurs. Check to ensure the high voltage microswitch is properly depressed.

Perform zero adjustment (Section 2-3, steps f thru h) and calibrate (Section 4-4) after probe repair, lamp replacement, or probe replacement.

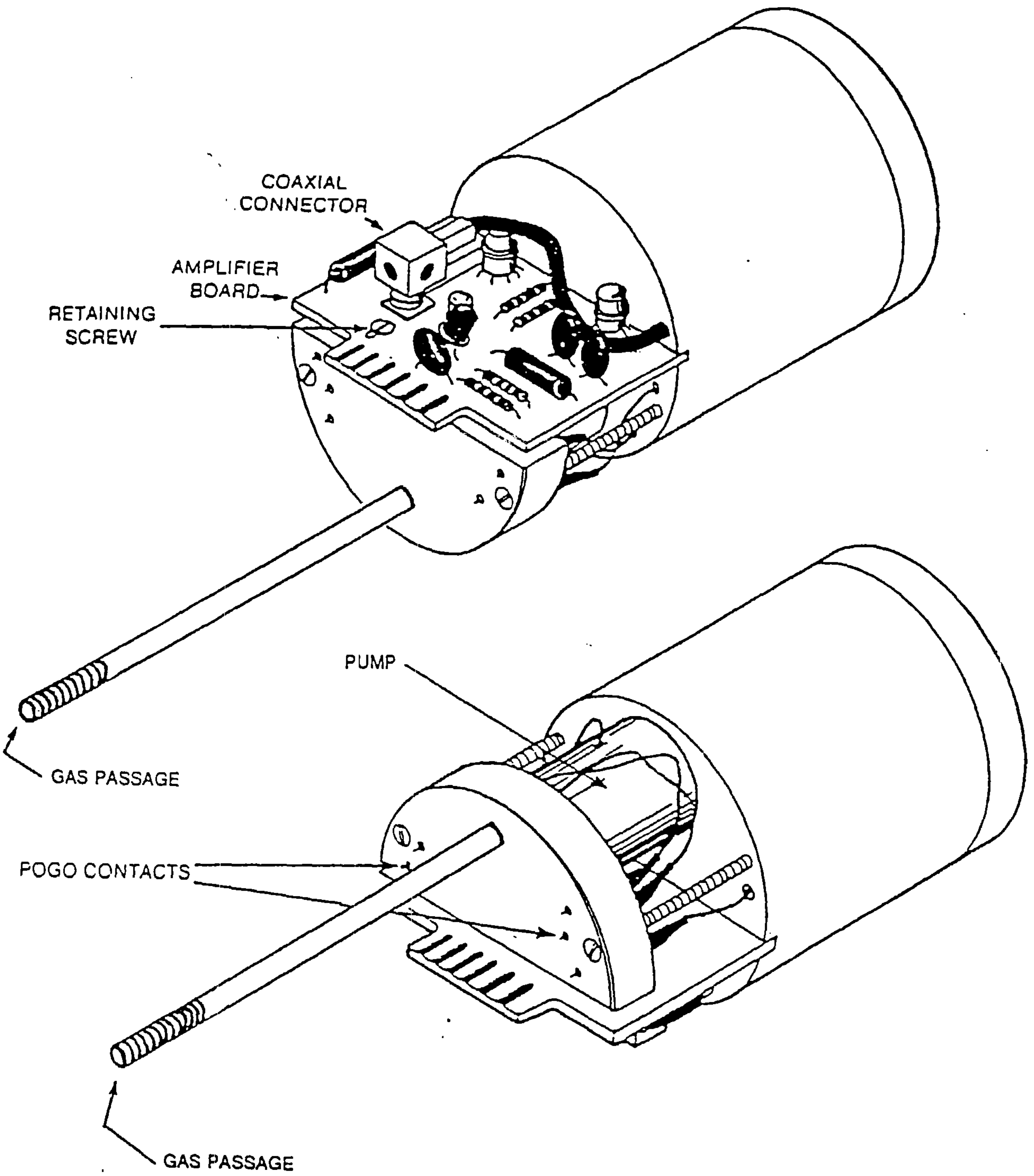


FIGURE 6-2
LIGHT SOURCE
SUBASSEMBLY

6-2.2 READOUT ASSEMBLY

WARNING

Turn the function switch on the control panel to the OFF position before disassembly. Otherwise, high voltage of -1200 VDC will be present.

Disconnect the probe cable connection. Loosen the screw on the bottom of the case and, holding the instrument by the bezel, remove the case. (See Fig. 6-3). Remove and replace the subassemlies as follows:

a. Control assembly - The control assembly is bonded to the bezel and is not removable.

b. Meter - The meter may be removed and replaced by the following steps. (Maintain sealing gasket in original location)

1) Disconnect the leads from the meter.

2) Remove 2 screws from clamps holding meter in place.

3) Loosen 2 nuts on clamps.

4) Move clamps inward to clear opening.

5) Move bezel with meter forward out of assembly.

6) Transfer the clamps to the new meter.

7) Reverse steps 1) thru 6) to install new meter.

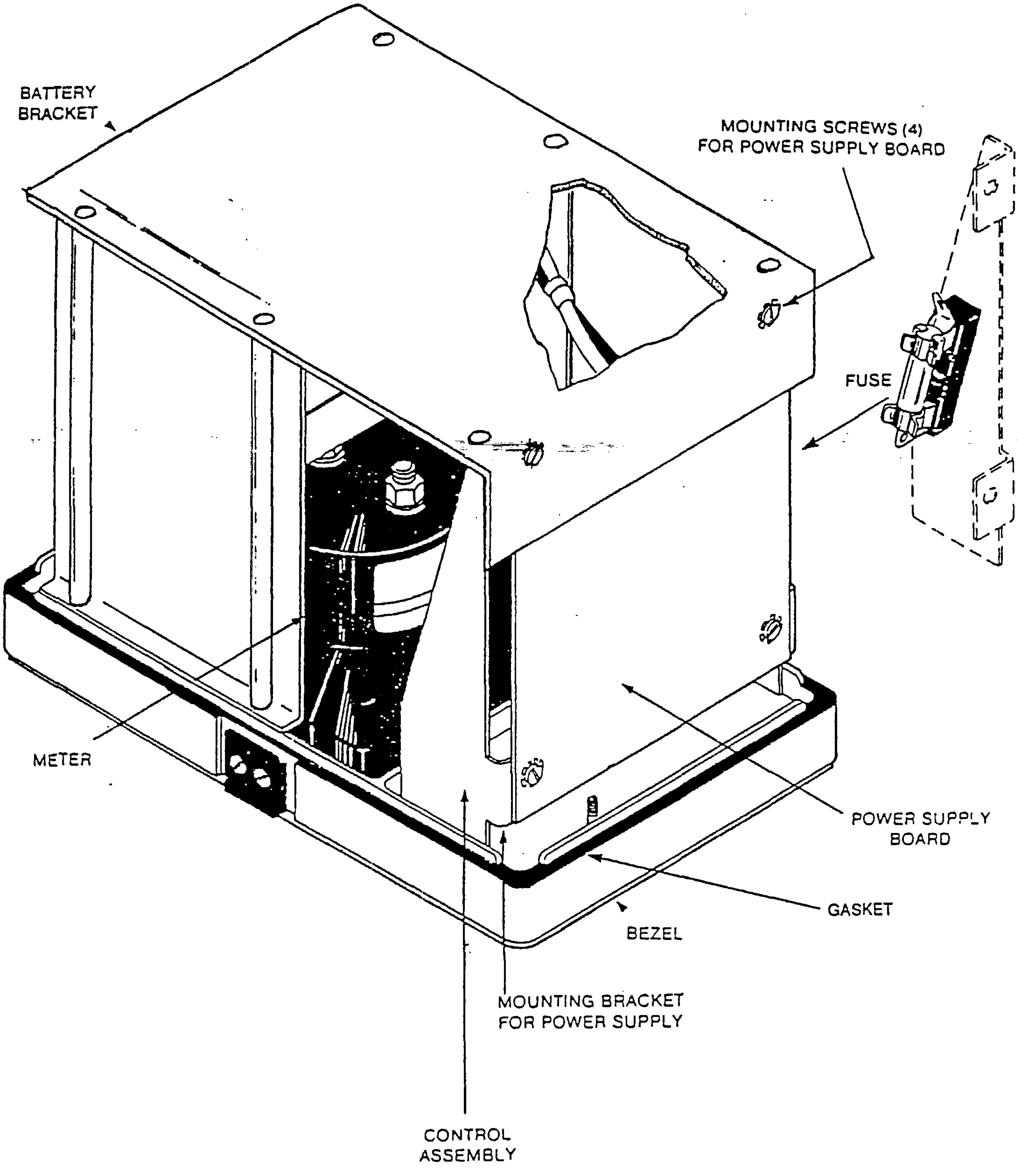


FIGURE 6-3
READOUT ASSEMBLY

c. Battery - The battery may be removed and replaced by the following steps:

1) Disconnect the molex connector to the battery.

2) Remove 4 screws on battery bracket holding battery in place.

3) Remove battery from the bracket on the end away from the control assembly.

4) Install new battery by reversing steps 1) thu 3) above.

5) On the power suply board, turn R53 (see Figure 5-2) a 20 turn 10k potentiometer, fully counter clockwise.

6) Charge the battery until fully charged (approx. 2 hrs).

7) Operate the analyzer on one of the three ppm range settings for 4 1/2 hours.

8) Adjust R53 (see Figure 5-2) in a clockwise direction until the low battery LED indicator just comes on.

9) Recharge the battery. The analyzer will now operate for 10 hours before the low battery indicator comes on.

GROUP ASSEMBLY PARTS LIST

Figure & Index No.	Part Number	Description 1 2 3 4 5 6 7	Units per Assy
1	AC103981	Probe assembly: provides gas detection	1
2	AD103960	Shell and cable assy: consists of shell, base, handle, knob cable and connector	1
3	DA100049-1	Exhaust screw	1
4	AC103980	Lamp Housing: provides housing p ifie PCB	1
		light source (lamp)	1
6	AB100008-A1	Pump Assy	1
7	AB102256-A1	Amplifier PCB	1
8	AD103983	Ion chamber assy	1
9	DB100053-1	End cap	1
10		Screw: end cap assy, 6-32 x 1 1/4 pin head, with internal tooth standard washer #6, both stainless steel	2
11	DB104124	Probe extension: 8" length	1
12	568-020	O-Ring: Ion chamber seal, 1" O.D., 70 Duro ARP, (90512)	1
13	568-012	O-Ring: Extension seal, 7/16" ID 70 Duro ARP, (90512)	1
14	568-005	O-Ring: seal, 7/32" OD, 70 Duro, ARP, (90512)	1
15	568-002	O-Ring: seal, 13/16" OD, 70 Duro, ARP, (90512)	1

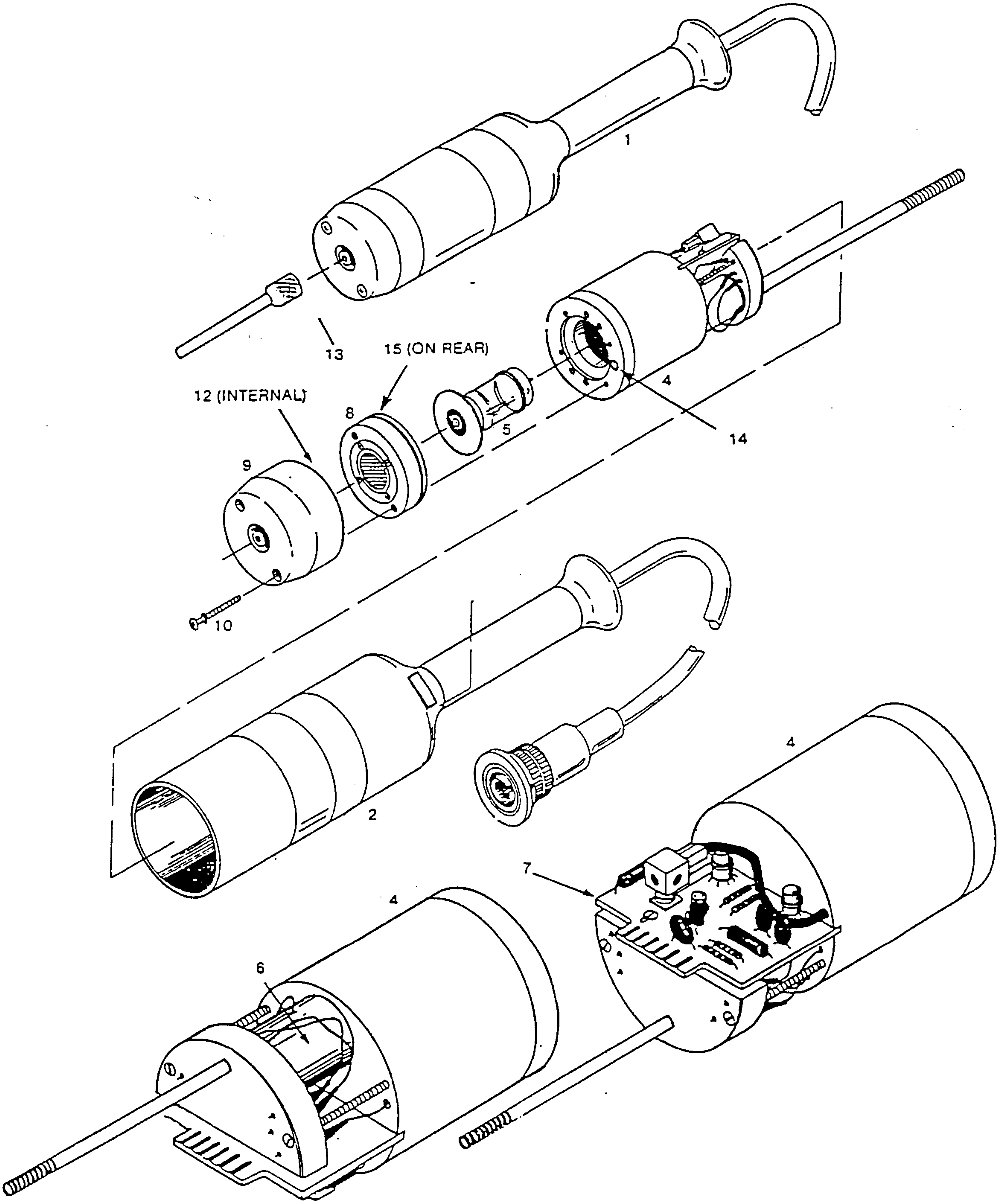


FIGURE 7-1
PARTS LOCATION, PROBE

GROUP ASSEMBLY PARTS LIST

Figure & Index		Part Number	Description 1 2 3 4 5 6 7	Units Per Assy
7-2		AC103959	Readout assy: provides control and indications	1
		AC103961	Meter & Bezel Assy	
	1	DC#00012-1	Meter: 4 1/2" (11.3 cm.), Taut band movement, graduated 0-5-10-15-20 division	1
	2	AB100086-A1	Switch: Function switch, rotary 6 position,(Ref Des: S1)	1
	3	DA101816-1	Potentiometer: span control, 10 turn 100K, Spectrol #534 (02111) (Ref Des: R51)	1
	4	DA100029-1	Potentiometer: zero adjust turn, 10K, CTS #VA45R103A (23223) (Ref Des: R50)	1
	5	AC103963	Control assy: consists of bracket power supply PCB, cable fuse and power jack	1
	6		Fuse: 2A, Bussman #AGC-2 (71400) or Fusetron #MDL-2 (07689) (Ref Des: F1)	1
	7	AA100011-A1	Battery: 12 V dc, 2.5 ampere-hours (Ref Des B1)	1
7-3	1	DB100017-1	Strap, neck: supports readout assy from neck of operator when in use	1
	2	DB100018-1	Strap, waist: secures readout assy to waist of operator when in use	1
	3	AC102269-A1	Charger, battery: 15.0 V dc, 120 Vac, 1ph input,	1
	4	DD102240	Case, cover	1
	5	DB100050-1	Case, readout assy	1
		AC103953	Display Driver Board Assy	
		AB103965	Low Bat Board Assy	

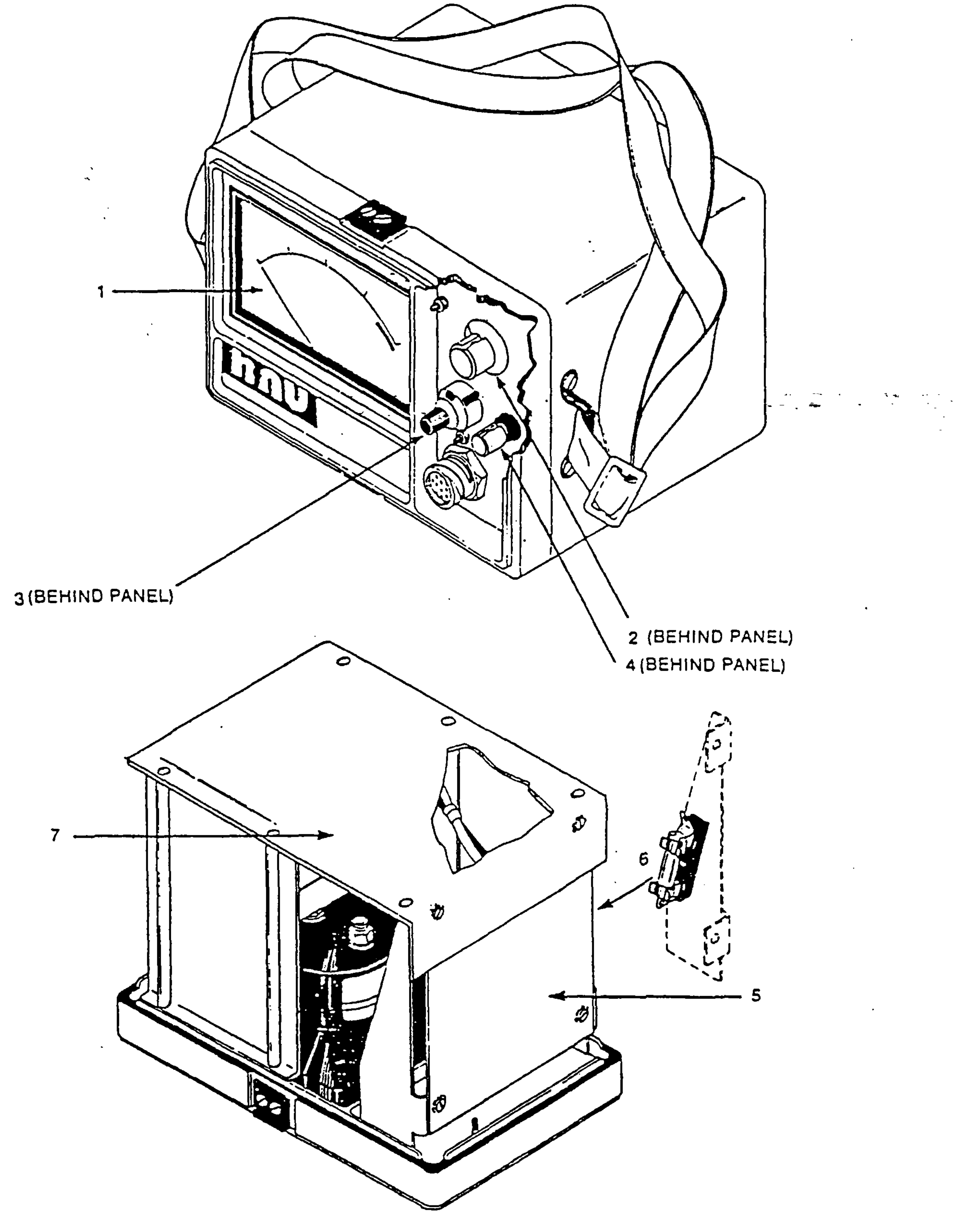


FIGURE 7-2
PARTS LOCATION, READOUT ASSEMBLY

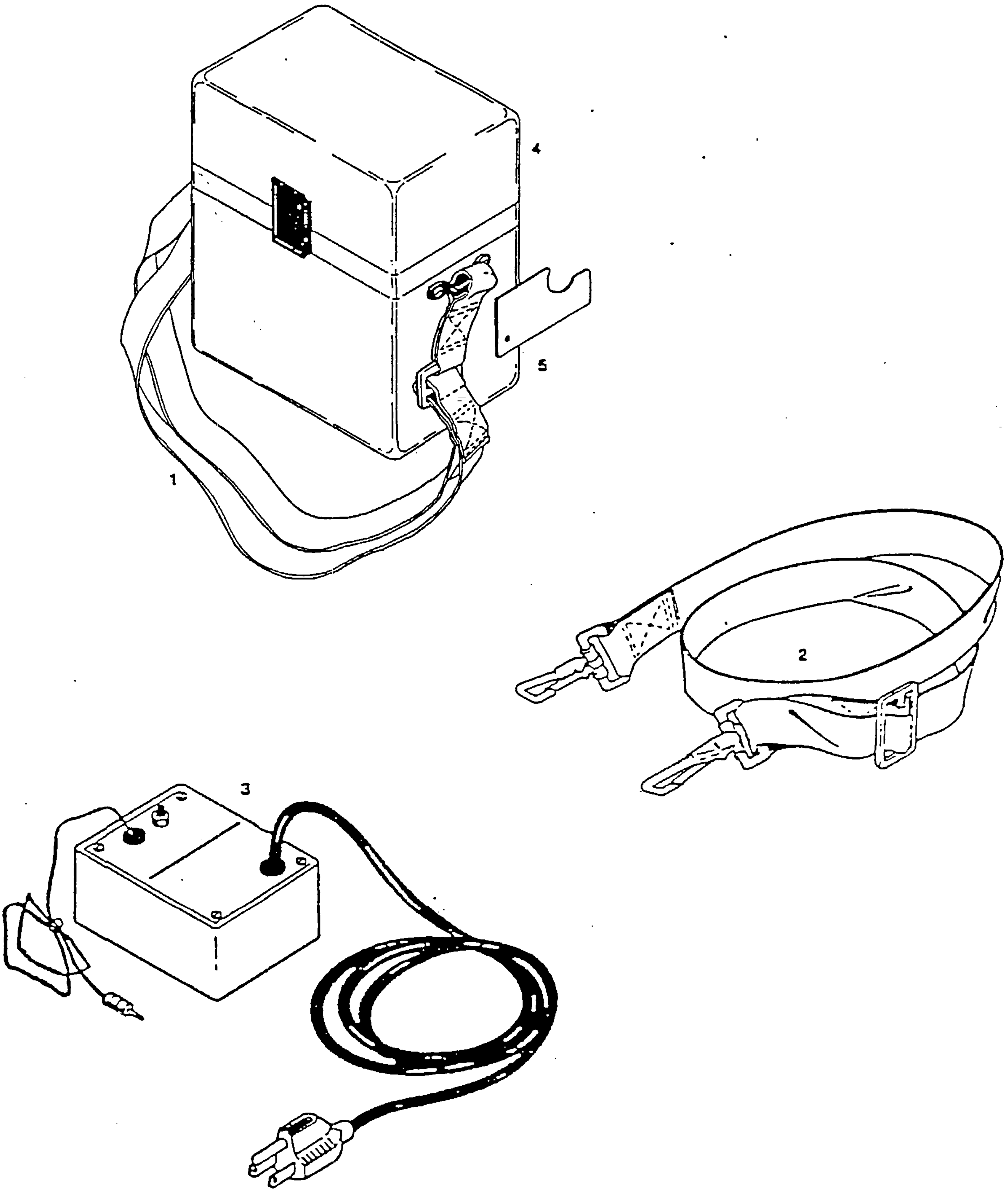


FIGURE 7-3
PARTS LOCATION, OUTER ASSEMBLY

NUMERICAL INDEX

Part Number	Figure and Index Number	Codes: Source	Codes: Maintenance	Codes: Recoverability
AD102242	1-1	PD	3L	L
AA100011-A1	7-2-7	PA	3L	L
AA100111-A1	7-1-11	PA	3Z	Z
AB100008-A1	7-1-6			
AB100086-A1	7-2-2			
AB102256-A1	7-1-7	PA	3L	L
AC100004-A1	7-1-2	PA	3G	G
AC100107-A1	7-1-4	PA	3Z	Z
AC102257-A1	7-1-1	PA	3L	L
AC102260-A1	7-2-5	PA	3L	L
AC102269-A1	7-3-3	PA	3Z	Z
AGC-2	7-2-6	PA	3Z	Z
OA100029-1	7-2-4			
DA100049-1	7-1-3	PA	3Z	Z
DA101816-1	7-2-3			
DB100017-1	7-3-1			
DB100018-1	7-3-2			
DB100050-1	7-3-5			
DB100053-1	7-1-9	PA	3Z	Z
DB100012-1	7-2-1	PA	3Z	Z
DD102240	7-3-4	PA	3Z	Z
MDL-2 or AGC-2	7-2-7	PA	3Z	Z
PA100009-A1	7-1-5	PA	3Z	Z
PA100010-A1	7-1-12 thru 7-1-15			
VA45R103A	7-2-4			
534	7-2-3			
568-025	7-1-15	PA	3Z	Z
568-005	7-1-14	PA	3Z	Z
568-012	7-1-13	PA	3Z	Z
568-020	7-1-12	PA	3Z	Z
AC100005-A1	7-1-8	PA	3L	L
DC102573	4-3-1	PA	3Z	Z
DC102579	4-3-2	PA	3Z	Z

REFERENCE DESIGNATION INDEX

Reference Designation	Part Number
B1	AA100011-A1
F1	AGC-2 or MDL-2
R50	DA100029-1, VA45R103A
R51	DA101816-1, 534
S1	AB100086-A1

AVAILABLE SPARE PARTS K1TS

PA100010-A1	O-Ring Kit: Contains two each of 568-020, 568-012, 568-005 and 568-002
PA-102743-A1	Five Piece Spare Parts Kit: Contains one each of PA100009-A1 UV light source, AA100011-A1 Battery, AB102256-A1 Amplifier PCB, AC102260-A1 Control Assembly and PA100010-A1 O-Ring Kit.
PA-102744-A1	Three Piece Spare Parts Kit: Contains one each of PA100009-A1 UC light source, AA100011-A1 Battery and PA100010-A1 O-Ring Kit.

Compur – Texas
(713) 839-7007
call for svc + pts

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ncolnshire, Illinois 60069
hone: 800-323-2000 (in IL 312/634-2800)
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9.05 - 1'

Bedienungsanleitung
Operating Instructions

COMPUR 4100 SD

Monitox HCN

Compur-Electronic GmbH

Gasspurenwarnsystem
COMPUR 4100 SD HCN

Das Gasspurenwarnsystem COMPUR 4100 SD HCN besteht aus

Gasdetektor	(Warngerät mit Anzeige)
Gasgenerator	*(Prüfgerät)*
Konsole	(empfohlenes Zubehör)
Protokollheft	(empfohlenes Zubehör)

Das System ist speziell für die MAK-Wert-Überwachung ausgelegt.

ACHTUNG!

Trotz der stark vereinfachten Bedienung durch den Endbenutzer ist das Monitox 4100 SD für HCN trotzdem ein komplexes Meßgerät, das eine sichere Funktion nur bei *sorgfältiger* Beachtung dieser Bedienungsanleitung und regelmäßiger Kontrolle durch die für den Einsatz des Gerätes Verantwortlichen gewährleistet. Dies gilt besonders für den regelmäßigen Zellenersatz sowie den täglichen Funktionstest. Das Einstellen der Warnschwellen liegt ebenso ganz in der Verantwortung des Betriebes; COMPUR empfiehlt die strenge Einhaltung der MAK-Werte. Eine Reparatur ist wegen des Ex-Schutzes nur durch den Hersteller zulässig.

Das Gerät wird von COMPUR mit folgenden Einstellwerten ausgeliefert:

Alarmschwellen:
1. bei MAK = 10 ppm HCN
2. bei 2 MAK = 20 ppm HCN

Die Detektorzelle wird bei HCN Konzentrationen über 1000 ppm irreversibel geschädigt. Dadurch geht die Anzeige nicht mehr auf „Null" zurück. In diesen Fällen muß die Zelle ausgetauscht werden.

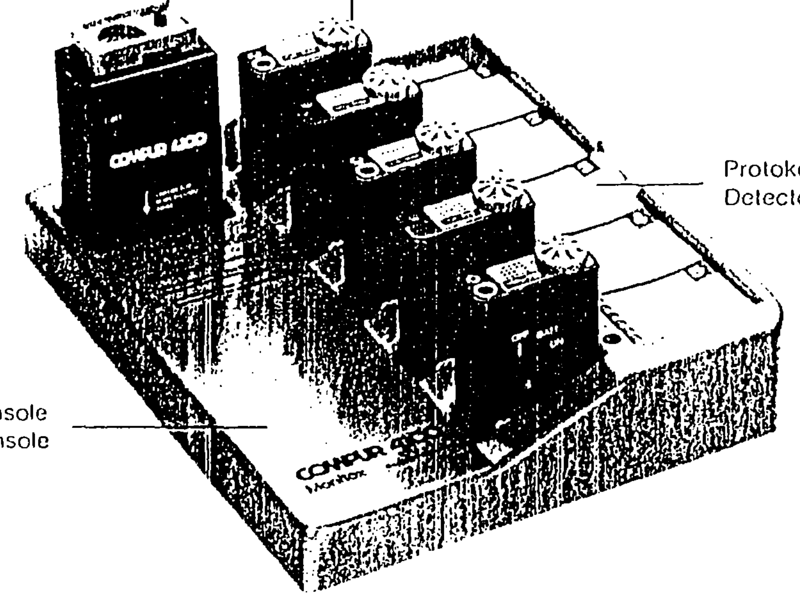

Abb. 1
Picture 1

Abb. 2
Pictur

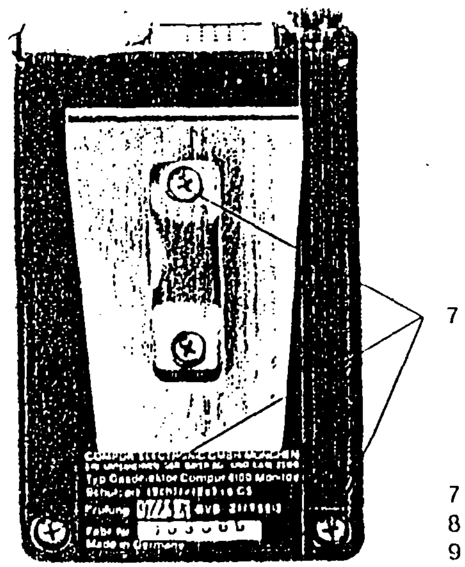

Abb. 3
Picture 3

7 Gehäuseschrauben
8 Dosimeterstecker
9 Ohrhörerstecker

7 housing scr
8 dosimeter p
9 earphone pl

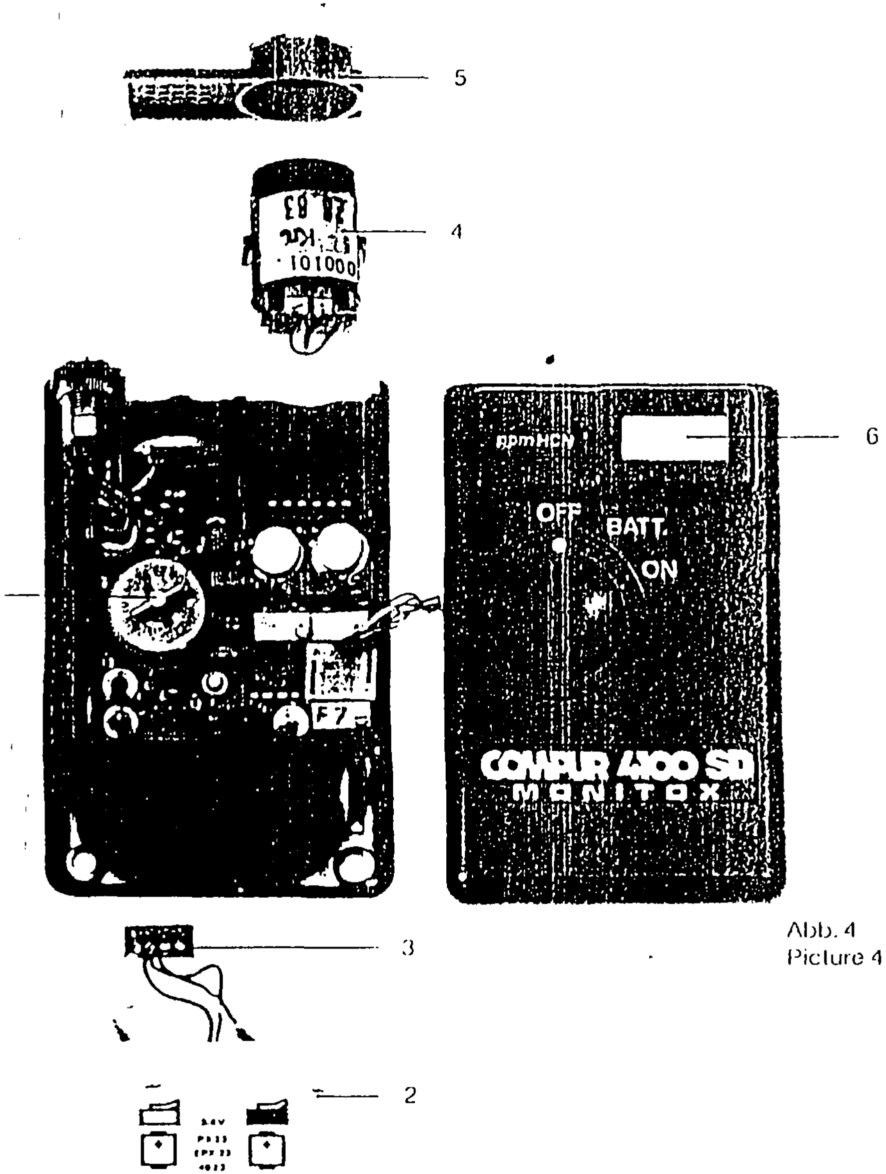

Abb. 4
Picture 4

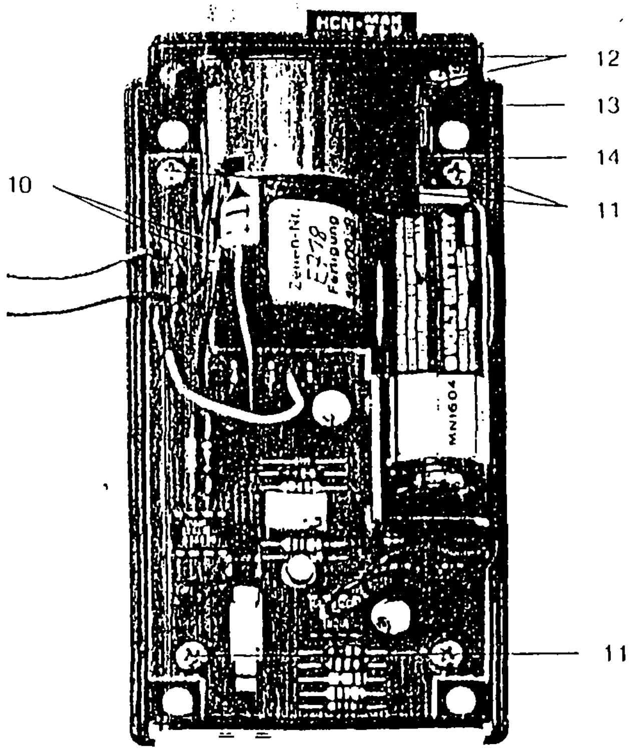

Abb. 5
Picture 5

1 Ein-/Aus-Schalter	1 On-/Off-switch
2 Batteriebehälter	2 battery pack
3 Stecker des Batteriebehälters	3 battery pack connector
4 Detektorzelle	4 detector cell
5 Filterkappe	5 filter cap
6 Display	6 display

10 Lüfteranschlüsse	10 fan leads
11 Leiterplattenschrauben	11 pcb-screws
12 Befestigungsschrauben	12 fan screws
13 Schaltstift	13 switch pin
14 Schalter	14 switch

…weise zur Fehlersuche

…r	Hinweis
…netest Detektor …nicht	Batterien wechseln (5.1.)
…tionstest mit …rator geht nicht	a) Evtl. mit 2. Detektor nachprüfen, ob Generator o. k., sonst b) b) Filterkappe wechseln (5.2.), wenn nicht verschmutzt, c) c) *neue Sensorzelle* einbauen (5.3.).
…rator liefert … genug Gas	Zelle befeuchten, d. h. mit Feuchthaltekappe mehrere Tage stehen lassen, sonst Generatorzelle wechseln (5.4.).
Generator …tet rote LED … Test auf	Generatorbatterie ersetzen (5.5.).

6.
Zubehör und Verbrauchsmaterial

Bestellnummern für Verkaufseinheiten

1. Gasdetektor HCN Digitalanzeige, 2 Alarmschwellen mit *Dosimeter-Anschluß*	U 5306 203
2. Zelle HCN mit Filterkappe	U 5800 103
3. Filterkappe HCN (10 Stück)	U 5810 341
4. Batterie PX 23 (1 Stück)	U 4990 001
5. Gasgenerator HCN	U 5390 300
6. Generatorzelle HCN	U 5820 300
7. Kalibriergasadapter	U 5900 106
8. Meßleitung: Eichen	U 5900 112
9. Digitalvoltmeter	U 5900 018
10. Stromgenerator	U 5900 023
11. Kalibrierkabelsatz für Stromgenerator	U 5900 125
12. Protokollheft	U 5900 004
13. Ohrhörer	U 5900 002

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Detection and Warning System
PUR 4100 SD Monitox HCN

COMPUR 4100 SD Monitox Gas
tion and Warning System comprises
detector (alarm unit with digital display)
generator (test unit)
sole (recommended accessory)
ectolog (recommended accessory)

system is especially designed to
tor the TLV of HCN.

TION!
ugh the 4100 SD Monitox for HCN has
highly simplified for ease of operation
e user, it is nevertheless a complex
suring instrument which will operate
ly only if these operating instructions
arefully observed and if the instrument
cked regularly by the safety officer.

This applies in particular to the regular replacement of the cells and daily functional tests. *The responsibility for any changes* made in the alarm threshold settings must be borne entirely by the operator; COMPUR recommends the strict observance of the TLV. *Since the unit is designed to be* intrinsically safe, all repairs must be made by the manufacturer or other approved personnel.

COMPUR offers the instrument with the following factory settings:
first alarm threshold = at TLV = 10 ppm
second alarm threshold = at 2 TLV = 20 ppm

The detector cell will be destroyed if the detector is permanently exposed to a HCN-concentration exceeding 1000 ppm. In this case the cell has to be replaced.

1. Technical Description of the COMPUR 4100 SD Monitox Detector for HCN

1.1. Applications

The COMPUR 4100 SD Monitox is a personal monitor for HCN.

It is designed to be worn attached to the clothing near the breathing zone of the person to be protected. The detector produces an audible first alarm when the HCN-concentration exceeds the TLV (factory setting: 10 ppm) and a second alarm, when it exceeds 2 x TLV.

Independent of the alarm setting, the digital display shows the actual HCN-concentration in ppm (parts per million) in the nominal range of 0 - 100 ppm HCN.

In conjunction with the COMPUR 4102 Dosimeter, the unit can be employed to register HCN-concentrations at confined spaces ranging from 0 to 10 x TLV.

The COMPUR 4100 SD Monitox cannot be used to measure process gas streams or in presence of continuous high HCN-concentrations.

1.2. Mode of Operation

Ambient air diffuses through the filter insert (a dust filter) (5) to the measuring cell. The measuring cell, a dual-electrode electrochemical cell with an organic electrolyte gel, generates an output current proportional to the partial pressure of HCN in the air.

A series of electronic amplifiers supply a voltage signal which is fed to the comparator for the alarm threshold. If the first alarm threshold is exceeded, an intermittent tone is produced; if the second alarm threshold has been exceeded a dual tone signal is produced by the tone generator and loudspeaker (or earphone in very loud areas). The standardised analog signal corresponding to the actual HCN-concentrations (the TLV corresponds to 80 mV) can be fed to the Dosimeter.

The same signal is fed to the AD-converter driving the digital display. The display is adjusted to give a reading of 10 ppm at 80 mV input.

The 4100 SD Monitox consists of two separate power circuits (via two miniature batteries); the circuit for the analogue part is separated from that for the alarm-generation.

When the „on-off" switch is moved to the „Batt." position, the batteries will be tested before the instrument is turned on. In this switch position, the batteries are electronically tested under the high load of the final tone stages. If one of the batteries fails to reach the predetermined lower theoretical limit, no alarm will be heard.

·nical Data for the COMPUR 4100 SD Monitox for HCN

rmity certificate		BVS 82.013
· class		EEx ib II C T 6
ısions		104,4 x 62 x 24 mm
ıt (with batteries)		approx. 150 g
r supply		2 x PX 23 (5,6 V)
y service life		approx. 1000 h.
ıy range		0 – 100 ppm
ı volume		min. 80 dBA / 30 cm
ı levels		2 alarms, adjustable
›nse time		$T_{20} < 10$ s $T_{90} < 3$ min.
to alarm	20 ppm 50 ppm	< 15 s < 3 s
ıection possibilities		earphone, dosimeter
ıerature range		0 – 50 °C
ıve humidity		10% – 95%
point drift		< 1 ppm / 6 months
ıtivity drift		< 15% / 6 months
ıce life of the cell		min. 6 months (dependant on dose)

1.4.
Cross-sensitivities

Test components	Test concentration	Indication in ppm HCN
SO_2	5000 ppm / 40% rH	10
NO_2	10 ppm	– 6
NH_3	1000 ppm	10
CO	1000 ppm	—
CO_2	1000 ppm	—
H_2	1000 ppm	—
$CH_2:CHCN$	10 ppm	—
CH_3CN	200 ppm	—
$(CH_3)N$	500 ppm	17
CH_3OH	200 ppm	—
$COCl_2$	5 ppm	10
Cl_2	10 ppm	5
HCl	10 ppm	7
H_2S	2 ppm	10
Hydrocarbons, saturated	2% vol.	—
Hydrocarbons, unsaturated	1% vol.	—
Aromatic compounds (also alcylated)	200 ppm	—

2.
Technical Description of the COMPUR 4100 SD Monitox Gas Generator for HCN

2.1.
Applications

The HCN gas generator serves to enhanc· the reliability of the Monitox gas detection and warning system. The Monitox detect·· must undergo a functional test by placing on the generator before each use. The generation of a gas concentration exceeding the TLV ensures that the detect will respond reliably during use (picture 2)

The gas generator, however, is not design· to generate a calibration gas of known concentration. Daily testing of the Monito detector does not mean that the user is n· recommended to change cell sequentiall·.

The COMPUR 4100 Gas Generator must not be exposed to or used in explosive atmospheres.

N.B.: The generator cell may dry out at very low relative humidity in the air. this case, it is necessary to put the moisture cap delivered with the generator on top of the generator always when it is not in use.

This ensures a correct gas concentration for the detector test

le of Operation

witch'on the generator is activated by ng the detector in the matching recess e generator head.

all fan feeds a flow of air past the rator cell directly to the detector cell. e same time, gas is generated rolytically in the generator cell in such nount that the gas concentration is enough to cause the detector to ond within 10 seconds (alarm threshold pm). The period of gas generation is ated by the green LED.

The red LED indicates when the battery must be replaced.

After a 10 seconds interval, gas production is terminated and the fan conveys pure air until the detector is removed.

This functional test of the detector checks any of the following defects:

- clogging of the dust filter
- a malfunctioning cell
- a malfunctioning electronics system
- a malfunctioning generator.

hnical Data of the COMPUR 4100 SD Monitox s Generator for HCN

ensions	133 x 65 x 40 mm
ght (incl. batteries)	approx. 250 g
perature range	0 °C – 50 °C
er supply	9 volt alkali battery, leakproof, e.g. Mallory 1604
erator cell service life	approx. 3000 tests or for 1 year
ery service life	approx. 3000 tests

3. Use of the detector and generator

3.1. Detector actuation and functional test

Battery Test

Turn the switch on the COMPUR 4100 SD Monitox to "Batt.". If the battery has sufficient power to operate the detector for eight hours, an audible (intermittent) tone will be heard. The LCD-display is switched off at the "Batt." test position. If no tone is emitted, this indicates that at least one of the batteries is exhausted. For safety reasons both batteries should be replaced (refer to section 5.1.).

When the audible tone has been heard (to preserve batteries, the test should be as short as possible), the switch is moved to "ON". The tone will cease. The LCD-display is operating now. It must show "0" ppm after some seconds.

Functional Test (picture 2)

Place the detector on top of the generator as illustrated.

As soon as the detector sounds its alarm, it must be removed from the generator. The detector is ready for operation once the alarm has ceased.

If the detector alarm does not sound withi ten seconds the detector has to be checke and serviced. If necessary, the filter cap ha to be replaced (see point 5.2.).

It is advisable to record the test and assignment of the gas detector in the detectolog.

The battery test and functional test must b performed prior to each use to thus ensur maximum safety.

During the gas test the LCD-display must show the response of the cell to HCN-concentration as well. As the alarm threshold is factoryset at 10 ppm the alar should sound at 10 ppm. As the display reads a new value every second, the time for alarm and display of 10 ppm may be different.

)f the Gas Detector

s detector must be worn in the ing zone of the person to be protected : filter cap (5) should not be covered way.

ober lip on the carrying clip makes it le to securely attach the Monitox to s of clothing (e.g. the breast pocket).

s not deemed adequately secure, the supplied with the Monitox can be d in the holes of the carrying clip. ables the Monitox to be worn around :k.

possible, the filter cap should be ted from water, dust-laden air or dirt. he battery and functional tests (refer it 3.1.) should be performed before tector is put into operation.

l gas concentration in the vicinity of sor exceeds the set alarm value, the will sound after a delay dependent on s concentration (The higher the ntration, the more quickly the UR 4100 SD Monitox will respond).

rm sounds at a level of at least 80 dB tance of about 30 centimeters hes).

3.3.

Connecting the Earphone

When the detector is being utilised in an area with high background noise, the optional earphone should be used to be sure that the alarm will not go unnoticed. The earphone is connected to the earphone socket (9) on the detector. This socket disconnects the internal loudspeaker. If the earphone is being used, it is important that the tests also be conducted with the earphone plugged into the detector (refer to point 3.1.). When the earphone is not being used, the socket should be closed with the plastic plug.

3.4.

Connecting the Dosimeter

The COMPUR 4102 Mini-Dosimeter can be connected to the 4100 SD (refer to operating instructions for the 4102).

The generator test can also be carried out with the Dosimeter connected to the COMPUR 4100 SD if the detector is turned 180° about its longitudinal axis relative to the position shown in point 3.1. and then placed on the generator in that way, that the cell fits into the recess on the generator. The functional test is then started by pushing the generator button with one's finger.

The plug should be replaced in the Dosimeter socket whenever the Dosimeter is not being used.

3.5.

Digital Display

Additional to the warning-function of the COMPUR 4100 SD Monitox its digital display (6) gives a direct reading of the actual HCN concentration.

Thus it is possible to determine HCN-concentrations below and above the TLV-level, giving the skilled worker and industrial hygienist the means to detect unusual conditions of HCN-concentrations with high accuracy and resolution.

The COMPUR 4100 SD Monitox is, however, even with its digital display, primary a measuring and warning device for personal protection.

It has not been designed for measurement in process-control; moreover exposures to high HCN-concentrations for any length of time must be avoided, as the accuracy of the reading will suffer.

3.6.

Detector Deactivation and Storage

a) brief period of inactivity (up to a month)

   the detector is deactivated
   (switch to "OFF")

b) Prolonged inactivity and storage

   It is advisable to open the Monitox and remove both the cell and batteries, to provide them from leaking and corroding the interior of the Monitox (refer to the sections on cell and battery replacement 5.3.).

   Before reutilizing the Monitox a new cell has to be installed.

ıbration Instruction for the
ɜctor COMPUR 4100 SD
ıitox

ıance the intrinsic accuracy of the
.tor for HCN it is necessary to calibrate
etector either with a HCN nitrogen
ıre with definite concentration of HCN
ıke an electronic adjustment by means
: COMPUR current generator
)0 023.

essories required

ıration with gas

ılibration cap to place onto Monitox
ıw meter
ıllivoltmeter 0 -- 2000 mV;
put resistance ≥ 1 M Ω
bing, set of test cables, screw-driver
ılibration gas, known concentration,
ıout 10 ppm HCN in pure N_2

ıark: The generation and above all the stability time of HCN calibration gas is not without problems. So if only a small number of detectors are to be calibrated, the electronic method should be prefered.

2.
bration – Electronical Method
ıre 6 and 7)

ılibration unit (current generator)
ıllivoltmeter 0 -- 2000 mV,
ıput resistance ≥ 1 M Ω
ıt of test cables, screw-driver

4.2.
Zero calibration and gain adjustment with calibration gas

4.2.1.
Preparation

The Monitox is opened and positioned with the electronic components upward on a non-slip surface. The cover with the digital display is carefully put aside with the display upward.

Then the unit is switched on via "Batt." position to "ON". The LCD-display should read 00 ppm after several seconds.

The excellent zero-point stability of the cells will normally make unnecessary to adjust the zero-point. Deviations from zero are caused mostly by fault sensor cells.

For zero-checking remove sensor cell.

4.2.2.
Zero-Adjustment

Connect Millivoltmeter to tie down point (MP 2) and GND (MP 1) (picture 6). If the reading is not zero in clean air, and also is not zero without sensor cell, potentiometer (R 9) (offset voltage) has to be varied until the reading is zero.

Note: If reading is zero without cell and not zero with the cell, it may need up to one hour to stabilize the cell. If a cell has been removed for a longer period without short-circuiting the two connectors, the time to stabilize may be up to one day. A new cell therefore has short-circuit on the small pcb, that must be broken away before inserting the cell.

4.2.3.
Gain Adjustment with gas

The special calibration adapter is tightly put onto the dust filter on top of the detector cell.

Adjust a calibration-gas flow through the calibration cap; flow rate should be approx. 100 ccm per minute and the inlet must be the smaller pipe; to avoid pressure variations the outlet should be free of obstacles. After 5 minutes the display of the Monitox has reached its final value.

Connect millivoltmeter to tie down point (MP 2) and GND (MP 1). Depending on the concentration of the calibration gas the following voltage should be displayed: (adjust by means of pot R 7)

$$U = \frac{[c] \text{ in ppm}}{10 \text{ ppm}} \times 80 \text{ mV}$$

The display of the Monitox must show the gas concentration. In the opposite, adjust pot (R 15) until correct reading is shown.

4.2.4.
Gain-Adjustment with the current calibrator

Each detector cell produced by COMPUR is supplied with an indication of the output current at 10 ppm HCN. (Never throw away packings of replacement cells before having noted this indication!!!)

Remove detector cell. Insert calibration cable with the plug board into plug connector for detector cell. The gold contacts must touch the spring contacts. Connect other side of the cable to the current generator.

Make sure of correct polarity of plugs. Switch on generator, turn button till generator display shows output current of detector cell.

Remark: Display always shows actual value of current. If it is zero, check the contacts!

Connect voltmeter to tie down point (MP : and GND. Adjust sensibility by means of pot (R 7) until 80 mV is displayed. Monito› must now display 10 ppm. In opposite, adjust pot (R 15).

4.3.
Setting the Alarm thresholds

The alarms of the standard version are to b› set on 10 ppm (first alarm 1 TLV) and 20 pp› (second alarm 2 x TLV).

To set the alarm levels, push the 2 mini-switches (S 1) to the right. The display of th› Monitox shows now the level of the 1st alarm threshold. This can be adjusted by means of the potentiometer (R 30).

To adjust the 2nd alarm level, push the upper switch to the left. The display show› now the 2nd alarm threshold. This can be adjusted by means of the potentiometer (R 29).

After having adjusted the alarm levels, pu› both mini switches to the left. The Monito› display shows now the actual concentrati› of HCN.

4.4.
Concluding the adjustment operations

After the settings have been made, turn th› switch on the pcb to "OFF"-position. Mak› sure that the switch-handle on the cover › also in the "OFF"-position. Then carefully replace the cover and fold the connectin› cable between pcb and display so that it › neither squeezed in nor cracked. Tighten the screws. The Monitox is now ready for operation.

aintenance and Servicing structions

1.

ıttery Replacement

lurn switch (7) to "OFF".
Remove three screws (12).
lurn detector over and remove front cover.
Attention: Do not attempt to remove the cable between front panel and pbc!
Lift out battery housing, disconnect plug.
Unscrew and remove battery lids.
Replace batteries with +pole towards lid.
Replace lids.
Plug-in battery plug. Ensure cable and cable socket in right position.
Replace battery housing and front cover, carefully adjust the cable of the front panel, so that it is not damaged by fixing the front panel; then tighten the screws.
Repeat battery test.

2.

lter Cap Replacement

Remove screws (7) (picture 4) and open detector.
Carefully remove sensor cell together with filter cap (5). Pull cap off cell (4).
Attach new filter cap (with identical gas label HCN) and return sensor cell to original position.
Filter cap order number appears on plate attached to inside of front panel and is listed in section 6.
Replace front cover and tighten screws
Repeat performance test.

5.3.

Sensor Cell Replacement

1. Open detector (see 5.1.).
2. Remove cell together with filter cap.
3. Remove new cell and filter cap from storage container, pull transparent cap off the cell and replace this by the new filter cap. Correct position of filter cap is shown in illustration.
   Remove short-circuit protection attached to pcb by breaking it away.
4. Proceed current calibration (4.2.4.).
5. Replace sensor cell with filter cap in proper position.
6. Close Monitox.

5.4.

Generator Cell Replacement
(picture 5)

1. Open housing
   (as when replacing battery)
2. Unsolder fan leads (10).
3. Loosen four screws (11) and three screws (12).
4. Remove outlet, gas cell and fan through the front.
5. Carefully insert replacement unit U 5820 300 consisting of outlet, cell and fan and tighten screws (12).
6. Tighten screws (11). Align circuit board so that pin (13) reliably actuates switch (14) when gas detector attached.
7. Resolder fan leads (10).
8. Reassemble generator and tighten screws.
9. Testing: Use properly functioning gas detector for same gas. Switch to "ON", attach. Alarm must sound after about eight seconds.

5.5.

Generator Battery Replacement

Loosen four screws on rear housing panel. Carefully remove front cover. For correct positioning of battery, refer to illustration 5.

5.6.

Troubleshooting

Malfunction	Remedy
Battery test: no response	Replace batteries (5.1.)
Generator test: no response	a) Repeat test using 2nd detector, if no response, b) b) Replace filter cap (5.2.), if not dirty, c) c) Insert new sensor cell (5.3.)
Generator does not supply enough gas	Use moisturizing cap for several days, otherwise replace generator cell (5.4.).
Red LED lights up during test	Replace generator batteries (5.5.).

6.

Accessories and consumable

Part Numbers

1. Gas detector digital display, 2 alarm thresholds with Dosimeter output	U 5306 20
2. HCN cell with filter cap	U 5800 10
3. HCN filter cap (10 pcs.)	U 5810 3
4. Battery PX 23 (1 pc.)	U 4990 00
5. HCN gas generator	U 5390 30
6. HCN generator cell	U 5820 30
7. Calibration gas adapter	U 5900 10
8. Measuring cable: calibration	U 5900 11
9. Digital Voltmeter	U 5900 01
10. Current calibrator	U 5900 0
11. Calibration cable used in connection with current calibrator	U 5900 1
12. Detectolog	U 5900 0
13. Earphone	U 5900 0

RADIATION ALERT™ MONITOR 4

Operation Manual

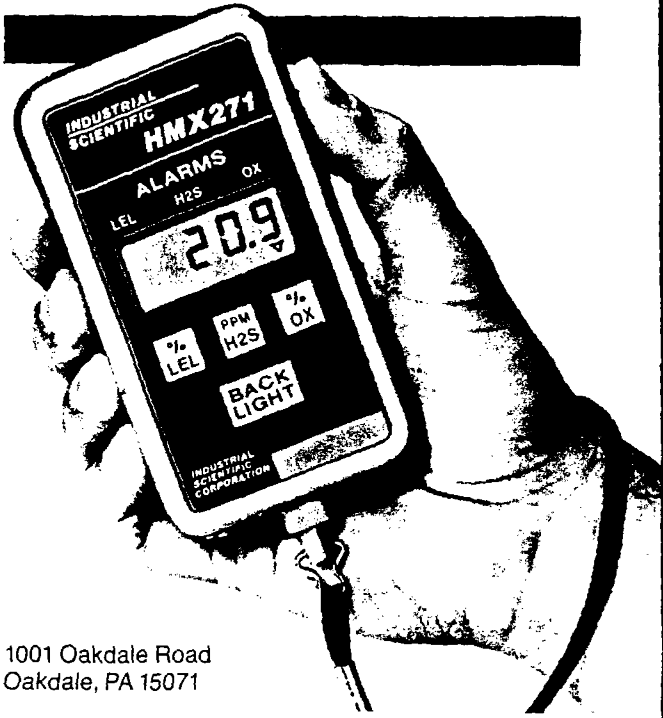
Solar Electronics International
156 Drakes Lane
Summertown, TN 38483

INDUSTRIAL
SCIENTIFIC

Model HMX271

Hydrogen Sulfide, Combustible Gas and Oxygen Monitor

Instruction Manual



1001 Oakdale Road
Oakdale, PA 15071

Call Toll Free: 1-800-DETECTS (338-3287)
U.S.A. and Canada
or (412) 788-4353

1703-6229

NOTE: ONLY THE COMBUSTIBLE GAS DETECTION PORTION OF THIS INSTRUMENT HAS BEEN ASSESSED FOR PERFORMANCE ACCORDING TO CSA STANDARD C22.2 NO. 152.

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1.0 GENERAL INFORMATION

1.1 Air and Gases

Air is a mixture of gases. Clean, dry air consists of 78.08 volume percent nitrogen, 20.95 volume percent oxygen, and 0.87 volume percent other gases including argon and carbon dioxide. Life, combustion and various chemical reactions are supported by oxygen. Human beings can tolerate moderate variations in the amount of oxygen in the air. Breathing becomes labored when the air contains only 16% oxygen. However, U.S. Department of Labor—OSHA (General Industry Safety and Health Standards 29 CFR 1910.94 (d) (9) (vi) requires the use of air-supplied respirators to provide adequate oxygen when the concentration of oxygen is less than 19.5%. Oxygen deficiency can be the result of the displacement of oxygen by other gases, aerobic bacterial activity, combustion, and the oxidation of metal.

A mixture of air and a combustible gas or vapor (hereinafter the term "gas" shall be understood to mean

combustible gases and/or vapors) will support the propagation of a flame away from a source of ignition only when the concentration of the gas, as a percent of the total volume of the mixture, is within the flammable range of that specific gas or combination of gases. An air/gas mixture in which the concentration of gas is below the flammable range will be too lean to propagate combustion. The flammable range has a lower limit and an upper limit; i.e., the lower flammable limit (LFL) and "lower explosive limit" (LEL) are equivalent, as are "upper flammable limit" and "upper explosive limit".

1.2 Warnings and Cautionary Statements

Certain conditions or failure to observe certain necessary procedures will impair the performance of the instrument. These are outlined below to be read and understood by any person using the instrument.

1.2.1 Oxygen deficient atmospheres will cause erroneous low determinations of the combustible gas content of the air.

1.2.2 Oxygen enriched atmospheres will cause erroneous high determinations of the combustible gas content of the air.

1.2.3 Verify the calibration of the combustible detecting mode of the instrument after use where the combustible gas content as a percent of the LEL was 100% or greater. Long continuous use (hours for one test) at high LEL concentrations (50% to 100%) may cause damage to the LEL detector, resulting in reduction of sensitivity and erratic behavior, including inability to calibrate. If this occurs, the LEL detector should be replaced.

1.2.4 Silicone compound vapors and sulfur compound vapors will cause desensitization of the LEL detector and thus cause erroneous low determinations. Verify the calibration of an instrument that has been used where these vapors were present before that instrument is relied upon for accurate measurements. Replace the LEL detector if the instrument cannot be calibrated.

1.2.5 Changes in the total pressure of the atmosphere due to changes in altitude will bear on the instrument's determination of the air's oxygen content. Calibrate the oxygen monitor mode of the HMX271 at the altitude at which it will be used.

1.2.6 Any rapid up-scale reading followed by a declining or erratic reading, or reading greater than 100% LEL, may indicate a gas concentration beyond the accurate response range of the LEL detector. Either take immediate corrective action to eliminate this potential hazard; or, withdraw from it.

1.2.7 Readings that are either negative or greater than 100% LEL may indicate an explosive concentration of combustible gas.

1.2.8 Obstruction of the screened sensor ports will cause erroneous low readings. These screens must be kept clean.

1.2.9 Sudden changes in temperature or pressure may cause temporary fluctuations in the oxygen reading.

1.2.10 Alarm device is nonlatching and will automatically reset.

2.0 INTRODUCTION

The HMX271 3-Gas Monitor continuously and simultaneously monitors ambient levels of oxygen, hydrogen sulfide, and combustible gases. All three gases are monitored simultaneously; only one is displayed on the instrument's liquid crystal display (LCD). When one of three membrane switches located immediately below the LCD panel is touched, the respective gas readout will appear on the display. A small triangular pointer also appears on the display, just above the switch that was pressed, to indicate which gas is being displayed. The last gas selected will remain on display until a different switch is pressed. The readout for the three gases may be selected in any sequence that the user desires. When the instrument is first turned on it will automatically display the oxygen readout. (See figure 1).

Although only one gas can be displayed at a time, all of the alarm circuits are active and continuously monitoring for unsafe conditions. If any of the gases reaches a preset safety limit, the audible and visual alarms are activated immediately. The audible alarm is a high pitched tone that alternates between two frequencies at the rate of approximately two times per second. A rectangular LCD enunciator appears near the top of the display panel to indicate which gas or gases caused alarm activation. The LCD will continue to display the readout of the gas range last selected by touching one of the membrane switches. (See figure 2).

Combustible gases are displayed in percent of lower explosive limit (LEL) in 1% LEL increments, Hydrogen Sulfide (H_2S) in parts per million (ppm) in 1 ppm increments, and oxygen (OX) in percent by volume in 0.1% increments.

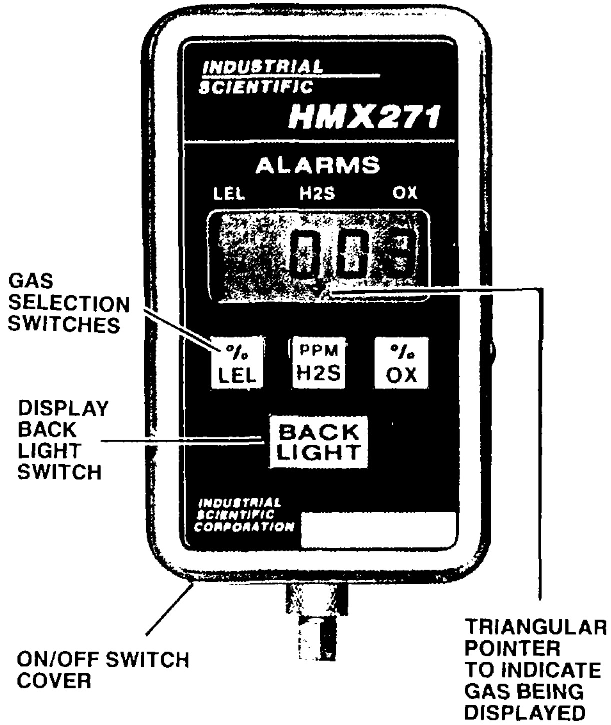


Figure 1.
HMX271 Controls

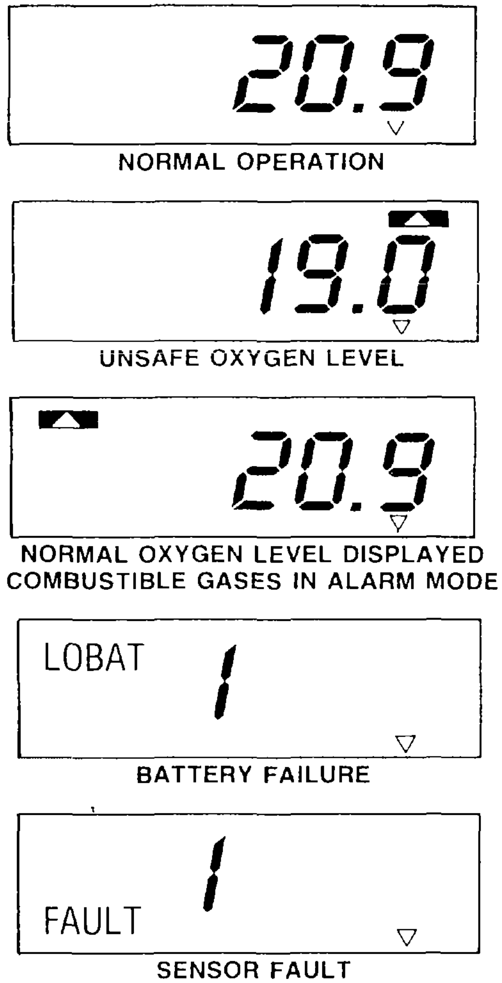


Figure 2.
Display and Alarms

Although primarily intended as a diffusion instrument, the monitor can be equipped for remote monitoring with an optional sampling pump (ISC Model SP200 or SP201).

3.0 UNPACKING

The shipping case should contain the following items. Account for each item.

TABLE I. PACKING LIST

QTY.	PART NO.	DESCRIPTION
1	1810-1139	HMX271 Hydrogen Sulfide, Combustible Gases and Oxygen Monitor
1	1703-6229	Model HMX271 Instruction Manual
1	1810-1204	Single Carrying Case
1	1700-6933	Calibration Cup
1	1700-7592	Tygon Tubing
1	1703-8803	Micro Screwdriver w/Hex Head

After unpacking, visually inspect each item for signs of physical damage. If damage is evident, contact either the local distributor of ISC detection instruments, or call Industrial Scientific at:

1-800-DETECTS (338-3287)
U.S.A. and Canada
or
(412) 788-4353

4.0 BATTERY PACK

Before Proceeding to use the Instrument. Charge the Batteries and Calibrate the Measuring Modes

NOTE: Instrument must be turned off before charging.

4.1 Charging the Batteries

The HMX271 requires a constant 75 milliamperes charging current. A completely discharged battery's full potential will be restored by 14 hours of charging. A Single Unit Charger, Part Number 1810-0123, and a Five Unit Charger, Part Number 1810-0115, are available from the local distributor of Industrial Scientific Corporation products. There is no danger of overcharging the batteries when using either of the above ISC 200 Series Constant Current Battery Chargers.

Apparent reductions in battery capacity may result from repetitive use patterns. A fully charged battery that does not deliver energy for at least 10 hours continuous monitoring may have developed a "memory" condition. To eradicate this, entirely discharge (until low battery warning) and then fully recharge the battery. The memory effect can be avoided by using the HMX271 so that the battery is discharged to varying depths.

The HMX271 is powered by a 750 milliamp/hour (mah) rechargeable nickel cadmium battery pack. When charged for 14 hours on any of the ISC charging units, the battery will power the monitor for a minimum of 10 hours. Typical run time will be approximately 12 hours. When the battery nears the end of its useful charge life (approximately ½ hour of operating time remaining), the monitor will start to emit short audible tone bursts to warn of a low battery condition. The tone bursts are two to three minutes apart and about one to five seconds in duration increase in length as the end of battery life approaches. When the battery is no longer capable of supplying sufficient power to the monitor, the monitor will go into the battery failure mode. The battery failure mode is indicated by all of the display digits being blanked except for the numeral (1) in the far left position; the word LOBAT appears in the upper left corner of the display; and the audible alarm sounds a continuous high pitched tone. (See figure 2). The above condition will continue for approximately 10 minutes or until the monitor is switched off. A 14 hour recharging then is needed to restore the battery to a full charge condition.

Note: After the monitor goes into the battery failure mode, it should be switched off within a few minutes. If the unit is not switched off within 10 minutes, inaccurate fluctuating readings will appear on the display and serious battery damage may result.

The HMX271 is also equipped with circuitry that detects LEL sensor faults. If a fault condition should occur, the monitor will go into a failure mode similar to the low battery failure mode and the word FAULT will appear in the lower left corner of the display. When the oxygen sensor is missing, audible and visual alarms are activated. (See figure 2.)

5.0 PREPARING FOR OPERATION

5.1 Switching ON the instrument (see Figure 3)

To switch on the instrument:

1. Back off the knurled nut that holds the calibration cover in place.
2. Rotate the cover so that the metal button is inserted in the oval-shaped hole.
3. Tighten the nut until the calibration cover is flush with the case. Do not overtighten.

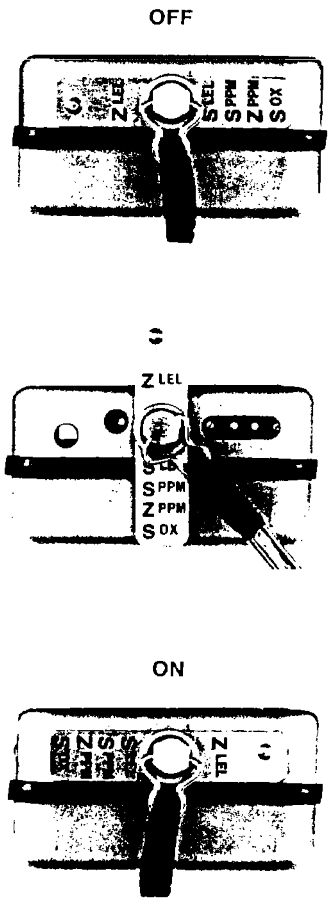


Figure 3.
Instrument ON/OFF

4. The monitor is ready for use as soon as the display stabilizes (approximately 60 seconds).

5.2 Switching OFF the instrument (see Figure 3)

To switch off the instrument:

1. Back off the knurled nut that holds the calibration cover in place.
2. Rotate the cover so that the metal button is inserted in the unmarked round hole.
3. Tighten the nut until the calibration cover is flush with the case. Do not overtighten.

6.0 CALIBRATION

6.1 General Information

Maximum safety will be insured by performing a calibration check on the HMX271 prior to each use. A calibration kit and replacement cylinders of calibration gas are available from ISC (see Table II).

For best calibration accuracy, the monitor should be allowed to stabilize at room temperature for at least one (1) hour before calibration.

TABLE II. CALIBRATION EQUIPMENT

Part No.	Description
1810-1279	Calibration kit, consisting of: Carrying Case Cylinder of Hydrogen Sulfide Cylinder of Pentane and Oxygen Regulator Calibration Cup
1810-0859	Replacement cylinder of Hydrogen Sulfide
1810-1238	Replacement cylinder of Pentane and Oxygen

6.2 Checking Alarm Settings

Before calibrating the instrument, it is good practice to check all of the alarm settings to verify that they are set correctly. The calibration cover must first be released and turned ninety degrees to expose the five calibration adjustments along the bottom end of the instrument. The function of the five control adjustments are: (1) LEL zero offset **Z LEL**, (2) LEL span sensitivity **S LEL**, (3) H_2S span sensitivity **S PPM**, (4) H_2S zero offset **Z PPM** and (5) OX calibration **S OX**. (See figure 4).

6.2.1 To Check LEL

To check the LEL alarm setting, switch the display to the LEL mode. Slowly turn the **Z LEL** (LEL zero offset) adjustment in the clockwise direction until the alarm is activated. When the alarm point is reached, slowly turn the adjustment back and forth through the point at which the alarm is activated. Observe the display. The display will show the percent of LEL at which the alarm is set to activate. Turn the adjustment back to the zero display reading. The factory setting for the LEL alarm is 10 %.

6.2.2 To Check H_2S

Checking the H_2S alarm setting is similar to the procedure used for the LEL. Switch the display to the H_2S mode and slowly turn the **Z PPM** (H_2S zero offset) adjustment in the clockwise direction until the alarm is activated. Slowly turn the adjustment back and forth through the point of activation and observe the display for the ppm level at which the H_2S alarm activates. Turn the adjustment back to the zero display reading. The factory setting for the hydrogen sulfide alarm is 10 ppm.

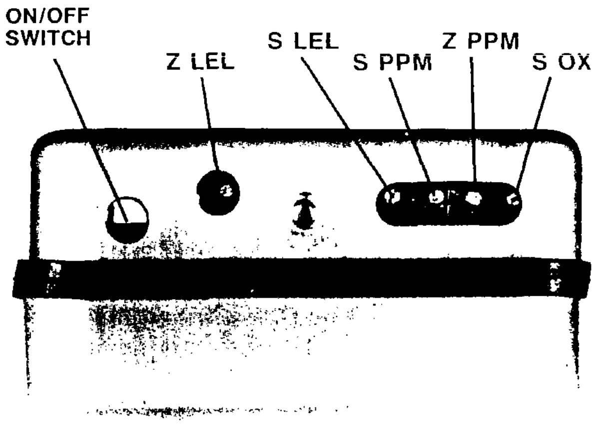


Figure 4.
Calibration Adjustments

6.2.3 To Check OX

Unlike the LEL and H_2S, the OX section does not require a Z adjustment. After switching to the OX mode, observe and note the display reading, which should be 20.9% in normal room air. Slowly turn the **S OX** (OX calibration) adjustment counterclockwise until the low oxygen alarm setting is reached. Slowly turn the adjustment back and forth through the alarm point to verify the setting. After the low alarm setting is located, slowly turn the adjustment in the clockwise direction until the high oxygen alarm setting is found. Slowly turn the adjustment back and forth through the alarm point to verify the setting. Return the display to the original setting. The oxygen alarms are factory set at 19.5% for the low alarm and 23.0% for the high alarm.

6.3 Adjusting the Alarm Settings

In order to access the four alarm adjustments on the HMX271, the instrument must be opened by separating the two halves of the case.

To open the case:

1. Use the micro screwdriver w/hex head to remove the screws on either side of the monitor.

2. Back off the knurled nut of the strap assembly as far as possible. Use a 5/16″ wrench to remove the center post of the strap assembly.

3. Lift the case top off the monitor. Set the case top (containing the electronics) aside, being careful not to damage the wires between the case top and bottom.

4. The alarm adjustments are located along the top end of the main printed circuit board and are identified with a label. (See figure 6).

6.3.1 Adjusting the LEL Alarm

Switch the display to the LEL mode and turn the **Z LEL** (LEL zero offset) adjustment, so that the display shows the desired level of LEL to which the alarm is to be adjusted. If the alarm is activated, the new LEL alarm is higher than the one currently set. Turn the LEL alarm adjustment, in the clockwise direction until the alarm is deactivated. Then, slowly turn the LEL alarm adjustment in the counterclockwise direction until the point is reached that again activates the alarm. The **Z LEL** adjustment should then be turned slowly back and forth through the alarm trip point to verify that it is correct. Return the display to zero.

6.3.2 Adjusting the H_2S Alarm

The H_2S alarm is set in the same manner as the LEL alarm with the exception of the display mode being switched to H_2S and the use of the **Z PPM** (H_2S zero offset) and the PPM alarm adjustments. In some instances, where the alarm is to be set very high, it may be necessary to turn the **S PPM** (H_2S span sensitivity) adjustment clockwise in order to set the desired level on the display. If the **S PPM** adjustment is moved, the instrument **must** be recalibrated.

6.3.3 Adjusting the OX Alarm

After the display has been set to the OX mode, use the **S OX** (OX calibration) control to set the desired level of the low oxygen alarm on the display. If the alarm is activated, the present setting is higher than the desired new setting. Turn the low alarm adjustment, in the counterclockwise direction until the alarm is deactivated. Now, turn the low alarm adjustment slowly clockwise until the alarm is once again activated. Slowly turn the **S OX** calibration control back and forth through the alarm point to verify the setting. Adjust the **S OX** calibration control so that the display reads the desired level for the high oxygen alarm. If the alarm is activated, the current setting is lower than the desired new setting. Turn the high alarm adjustment, in the clockwise direction until the alarm is deactivated. Now, turn the high alarm adjustment slowly in the counterclockwise direction until the alarm is once again activated. Turn the **S OX** calibration control back and forth through the alarm point to verify the setting. Return the display to its original setting.

Note: It is possible to overlap the high and lower oxygen alarm settings. If this happens, the alarm will be activated for all oxygen levels. To exit this condition, turn the high oxygen alarm to its highest clockwise position and the low oxygen alarm to its lowest counterclockwise position and repeat procedure 6.3.3.

Reassemble the monitor and perform calibration of all three gases.

7.0 ZERO ADJUSTMENTS

Only the H_2S and LEL sections of the HMX271 require zero calibration. (See figure 5). In clean air, switch the display to the H_2S mode and adjust the **Z PPM** (H_2S zero offset) by turning it counterclockwise until the minus sign (–) appears on the display. Very slowly turn the **Z PPM** control clockwise until the minus sign just goes off, leaving (000) in the display.

In clean air, switch the display to the LEL mode and adjust the **Z LEL** (LEL zero offset) control by turning it counterclockwise until the minus sign (–) appears on the display. Very slowly turn the **Z LEL** control clockwise until the minus sign just goes off, leaving (000) in the display.

8.0 SPAN ADJUSTMENTS

After the LEL and H_2S zeros have been properly set, the span sensitivity may be calibrated. Switch the display to the LEL mode, and apply the span gas of 25%

Figure 5.
Calibration Cup

LEL Pentane (see note 1) to the monitor using the calibration cup. Allow the gas to flow for two (2) minutes. With the gas still flowing, adjust the **S LEL** (LEL span sensitivity) control, on the bottom of the instrument, so that the display reads the percent of LEL, to the nearest percent, that is printed on the calibration gas cylinder. Remove the calibration gas.

Repeat the above procedure for H_2S using a known concentration of hydrogen sulfide span calibration gas with the **S PPM** (H_2S span sensitivity) control to complete the span calibration.

In clean air, known to have 20.9% oxygen, the **S OX** (OX calibration) control should be adjusted so that the display reads 20.9% oxygen. Final calibration of the oxygen readout should only be done in free air if the user is sure that the air contains the normal 20.9% oxygen. The readout should then be adjusted so that the display reads 20.9%. If there is any doubt of the oxygen content of the air, calibration gas of a known percentage of oxygen in nitrogen should be used.

Note 1

Industrial Scientific Corporation recommends that the calibration gas used for general combustible gas measurement is 25% LEL pentane. If you are measuring a known combustible gas, span calibration should be made using a known % LEL concentration of that gas.

9.0 MAINTENANCE

9.1 Screen Replacement

Specially treated stainless steel screens protect the sensors from direct impact and dust particles.

To remove the screens:

1. Remove the four (4) screws that hold the bezel and screens in place.

2. Forced air cleaning may not remove very fine dust particles clogging the screens. NEVER use any type of solvent to clean the screen, since they may degrade sensor performance. Screens that cannot be cleaned should be replaced. See replacement parts list.
3. Reassemble the screen and bezel to the monitor.

9.2 Battery Pack Replacement

Since it is normal for gas detection sensors and batteries to deteriorate with age, the HMX271 has been designed so that it is possible to replace all of the sensors and the battery using only simple hand tools. No soldering is required. In all cases, it is necessary to separate the two case halves. Always handle the opened instrument carefully to prevent damage to the wiring harness. The top half of the case should be flipped over and allowed to lay face down next to the bottom half of the case.

To replace the battery, first locate the battery wires that lead to a small two (2) terminal connector located at the far left end of the regulator printed circuit (PC) board. (See figure 6). Carefully pull the connector from the PC board and lift the battery from the case. It may be necessary to gently pry the battery free with a small screwdriver or similar object. Install the new battery in reverse order and carefully lay the battery leads down against the regulator PC board before reassembling the case halves.

9.3 Oxygen Sensor Replacement

Replacement of any of the sensors requires that the bezel and screens be removed first. This should be done prior to separating the case halves.

Note: Before replacing any of the sensors, pull the battery connector off to remove power.

To replace the oxygen sensor, first locate the small black connector in the sensor leads and carefully pull the two halves apart. Locate and remove the two long #2 screws that go through the front of the case bottom and into the oxygen sensor retaining bracket. Lift the oxygen sensor and bracket out of the instrument. When the sensor is removed, the plastic mounting ring may adhere to the sensor surface. The ring should be reinstalled in its original position. Next, install the new sensor in reverse order and reassemble the instrument.

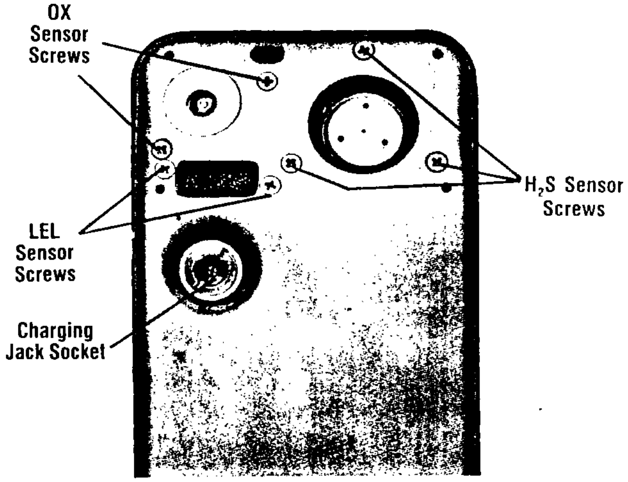
Note: It is normal for the instrument to go into the high oxygen alarm immediately after a new oxygen sensor is installed. After the new sensor is connected to the instrument, it takes approximately ten minutes for the sensor to stabilize.

9.4 Hydrogen Sulfide Sensor Replacement

In order to replace the hydrogen sulfide sensor, the oxygen sensor must be removed first. After the oxygen sensor has been removed, locate the three long #2 screws that extend through the instrument case bottom and into the threaded inserts on the sensor PC board. Lift the PC board, with the sensor attached, from the instrument case bottom. The sensor is connected to the PC board by small pins that are inserted into sockets on the board. Remove the sensor by pulling it free of the sockets. The new sensor will have a small wire that shorts two of the terminals. Remove this wire and insert the new sensor into the sensor PC board. Reassemble the instrument in reverse order.

9.5 Combustible Gas Sensor Replacement

To replace the LEL sensor, it is first necessary to remove the oxygen sensor. After the oxygen sensor is removed, locate the three circuit connector that connects the LEL sensor to the regulator PC board and disconnect it. (See figure 6). Locate and remove the two screws that mount the LEL sensor to the case bottom. Carefully remove the sensor from the case bottom. Install the new sensor in the reverse order. Make certain that the sealing gaskets are properly installed, when mounting the new sensor. Reassemble the instrument in reverse order.



Back view
with Bezel and
Screens removed

Figure 6.
(Continued on fold-out page)

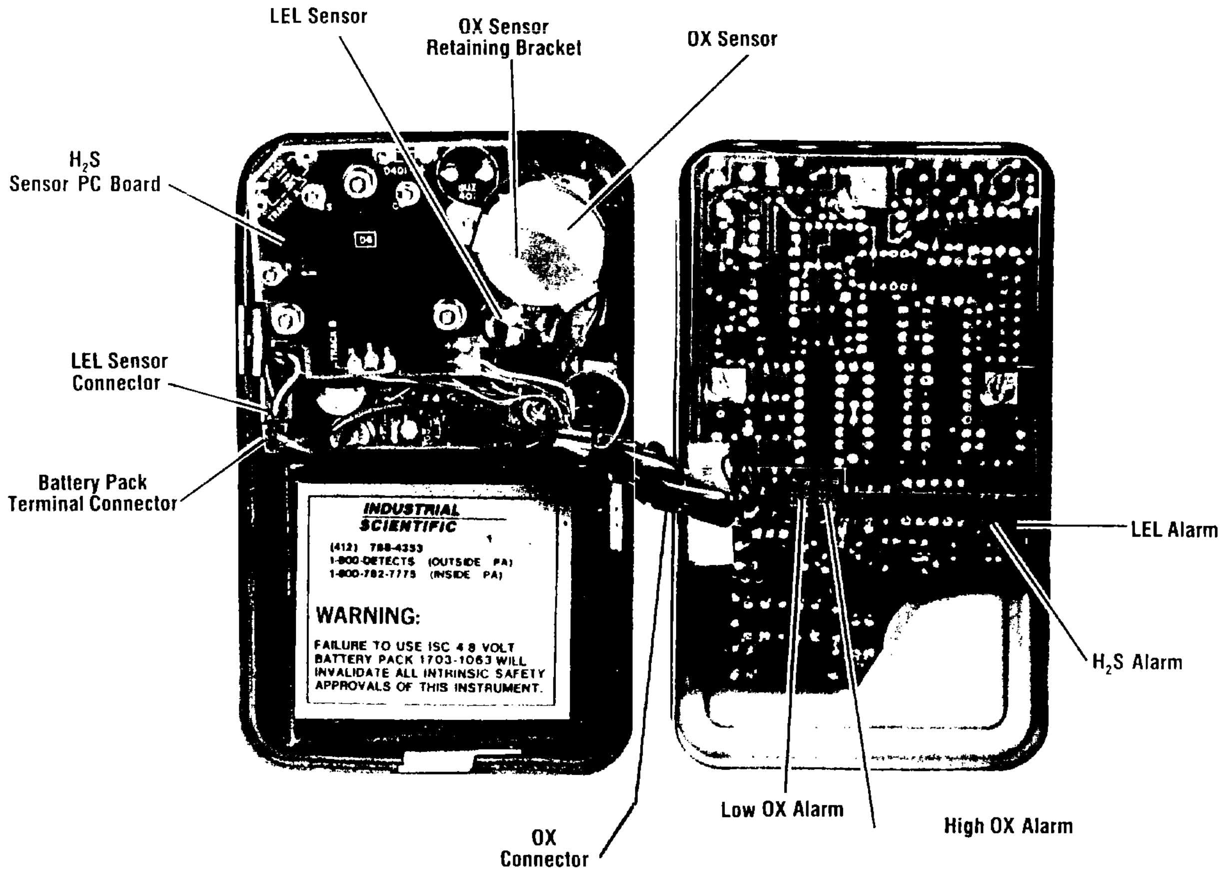


Figure 6.
Battery Pack and Sensor Replacement

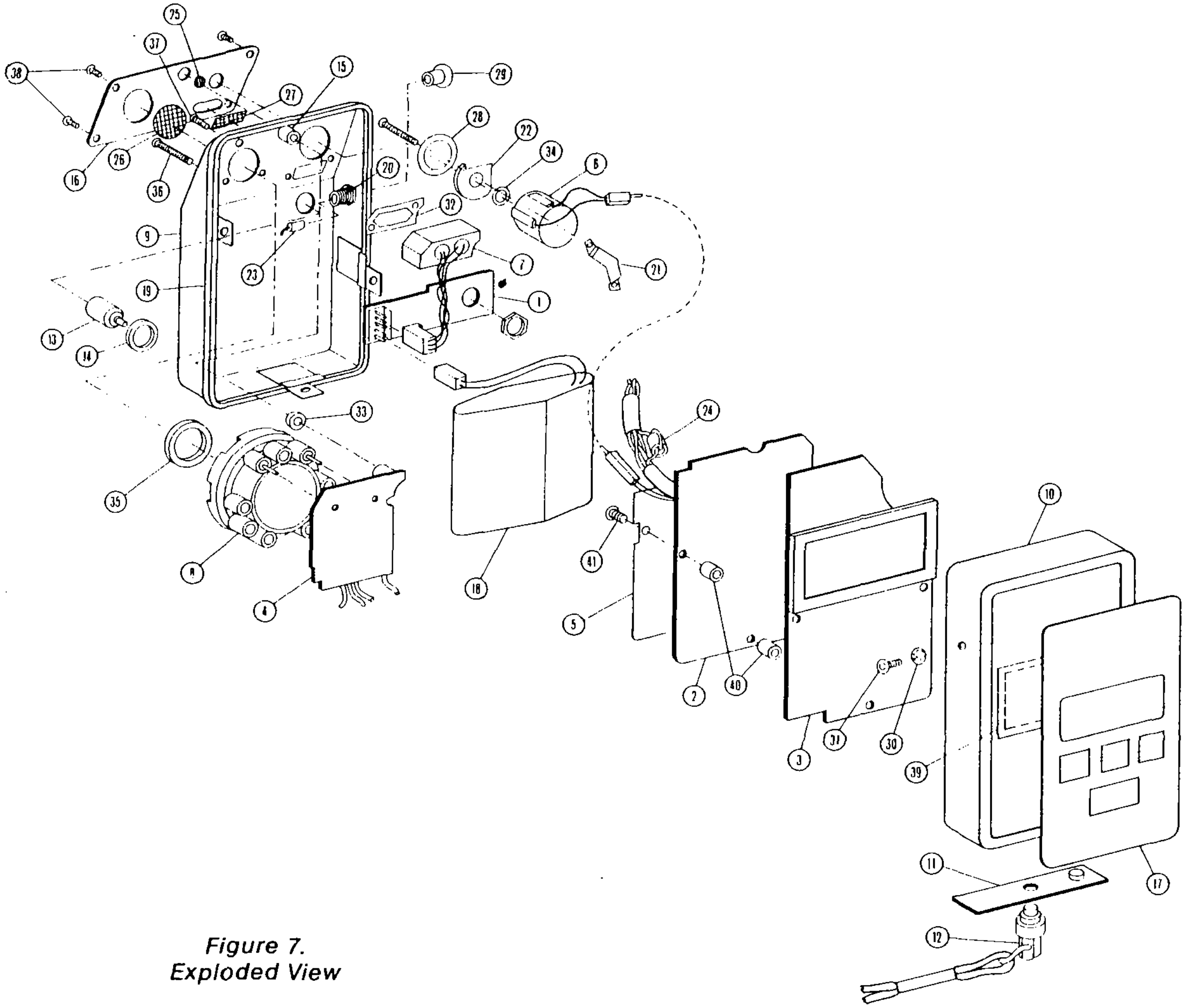


Figure 7.
Exploded View

10. REPLACEMENT PARTS LIST

Item numbers refer to Figure 7, Exploded View.

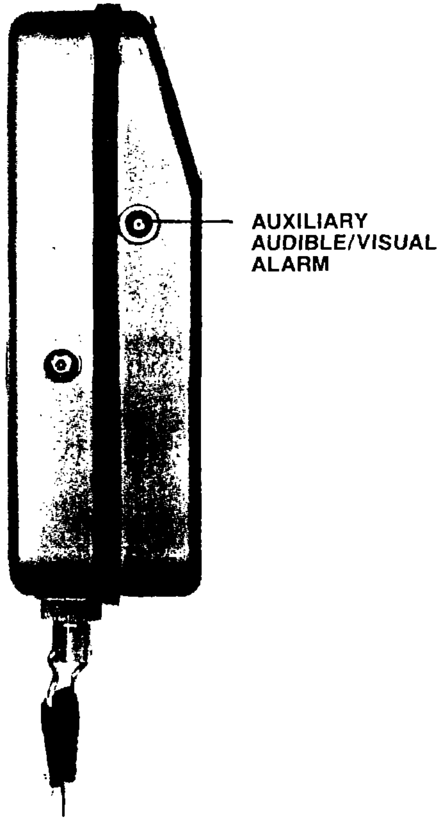
TABLE III. REPLACEMENT PARTS

Item	Part No.	Description
1	1703-1204	Regulator PC Board Assembly
2	1702-9117	Main PC Board Assembly
3	1702-9018	Display PC Board Assembly
4	1702-8762	Sensor PC Board Assembly
5	1703-1444	Insulator Assembly
6	1703-5114	Oxygen Sensor
7	1703-1287	Combustible Detector
8	1702-2062	Hydrogen Sulfide Sensor
9	1702-8614	Case Bottom Assembly
10	1703-0081	Case Top Assembly
11	1703-1600	Calibration Cover Assembly
12	1700-4078	Instrument Strap
13	1700-1660	Charging Jack Socket
14	1702-8630	Charging Jack Bushing
15	1703-0644	Buzzer Adapter
16	1702-8648	Bezel, 3-Gas
17	1702-9091	Faceplate HMX271
18	1703-1063	Battery Pack Assembly
19	1703-1782	Gasket
20	1702-8374	Receptacle
21	1703-1238	Oxygen Sensor Clamp
22	1703-2467	Oxygen Sensor Cap
23	1703-1527	Ferrite Bead
24	1703-1535	Ferrite Bead
25	1703-0669	Buzzer Screen
26	1703-1154	Hydrogen Sulfide Sensor Screen
27	1703-1345	LEL Detector Screen
28	1703-2475	Tape, Transfer
29	1702-9273	Hole Plug
30	1701-9787	Washer, LKG, #6
31	1701-3558	Screw, 6-32 x 3⁄16

32	1703-1329	Gasket (part of item 7)
33	1703-0651	Seal (part of item 4)
34	1703-0610	Oxygen Sensor Seal
35	1703-1303	Hydrogen Sulfide Sensor Gasket
36	1702-8457	Screw, 2-56 x 1.00
37	1703-0693	Screw, 2-56 x .25
38	1701-7914	Screw, 2-56 x .12
39	1703-1618	RF Screen
40	1703-1089	Spacer
41	1703-1774	Screw, 4-40 x .25

For your convenience and protection, record the serial number of your HMX271 Monitor in the space provided.

Serial No. ______________________



For those instances where a high noise environment is encountered, a jack is provided on the side of the HMX271 case for use with the remote audible/visual alarm.

Figure 8.
Side View

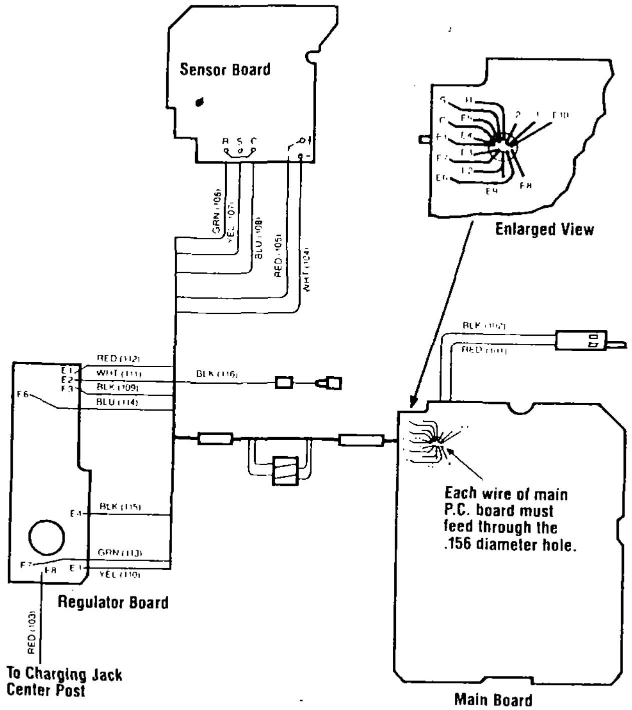


Figure 9.
Wiring Diagram

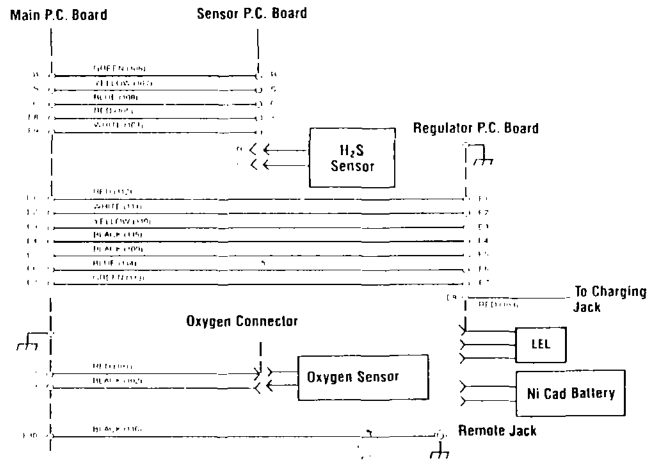


Figure 9.
Wiring Diagram

11.0 SPECIFICATIONS

11.1 Physical and Components

Case:	Stainless steel, dust tight, splash resistant
Dimensions:	4.75 x 2.75 x 1.5 inches (121 x 70 x 38 mm)
Weight:	22 ounces
Sensors:	Hydrogen Sulfide — Electrochemical Combustible Gases — Catalytic, Diffusion Type Oxygen — Electrochemical
Power Source:	750 mA hour rechargeable, nickel cadmium battery pack
Battery Life:	Minimum 10 hours per battery charge
Readout:	Digital liquid crystal display
Alarms:	Pulsing visual and audible alarms. Continuous visual and audible low battery alarms accompanied by display blanking. Expiring batteries indicated by a unique audible warning signal. Audible and visual alarms are activated when the oxygen sensor is missing. When the combustible gas sensor is open or missing, the fault condition will occur, and the audible alarm will sound a continuous tone.

11.2 Performance

Measuring Range:	Hydrogen Sulfide — 0 to 1999 parts per million (ppm) Combustible Gases — 0 to 99% LEL Oxygen — 0 to 30% of volume

11.3 Environmental Factors

Temperature Range: −15°C to +45°C

Humidity Range: 0-95% RH (Noncondensing)

INDUSTRIAL SCIENTIFIC CORPORATION

1001 Oakdale Road
Oakdale, PA 15071

Call Toll Free: 1-800-DETECTS (338-3287)
U.S.A. and Canada
or
(412) 788-4353

1704-2300

INDUSTRIAL SCIENTIFIC

Model SP202

Sampling Pump

Instruction Manual

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1.0 INTRODUCTION

The SP202 Sampling Pump (in conjunction with one of Industrial Scientific's 200 Series Gas Monitoring Instruments) can be used for remote sampling when it is unsafe for the instrument user to enter the area where an atmospheric determination is to be made. The SP202 is also useful for testing otherwise inaccessible areas.

The SP202 Nicad Pump is powered by a nickel cadmium battery pack that provides a minimum of 14 hours (@ 25°C with 10 ft. tygon tubing) of continuous operation. Battery chargers are available to recharge the SP202's batteries.

The SP202 Alkaline Pump is powered by (4) disposable, AAA size alkaline batteries. The batteries provide 10 hours (@ 25°C with 10 ft. tygon tubing) of continuous operation. The pump is factory shipped with batteries installed.

An external, user replaceable dust filter (P/N 1702-4597) is designed to protect internal pump parts.

2.0 UNPACKING

The shipping carton should contain the following items. Account for each item before discarding the carton.

TABLE I. PACKING LIST

Qty	Part No.	Description
1	1810-1782	SP202 Sampling Pump (Nicad)
	or	
1	1810-1790	SP202 Sampling Pump (Alkaline)
1	1700-7774	1/16" Allen Wrench
10'	1700-7592	Sampling Hose
1	1702-7152	Water Stop

After unpacking, visually inspect each item for signs of physical damage. If damage is evident, contact either the local distributor of detection instruments, or call Industrial Scientific Corporation at:

Call Toll Free: 1-800-DETECTS (338-3287)
U.S.A. and Canada
or
(412) 788-4353

3.0 OPERATION

3.1 Faceplate

The SP202 faceplate is protected by a transparent film that may be peeled off if desired.

WARNING

Before using the SP202, test the unit to ensure that it is operating properly. A failure of internal components could cause inaccurate instrument readings due to failure to draw a proper sample. Return the SP202 to either Industrial Scientific or an authorized distributor for repair if a problem should occur. Refer to Section 3.2.

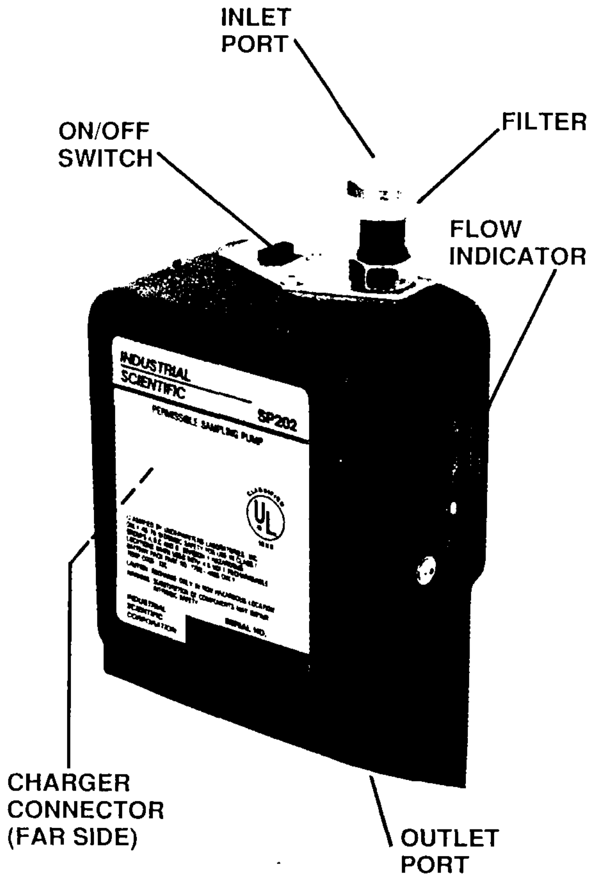

Figure 1.
SP202 Controls (Nicad)

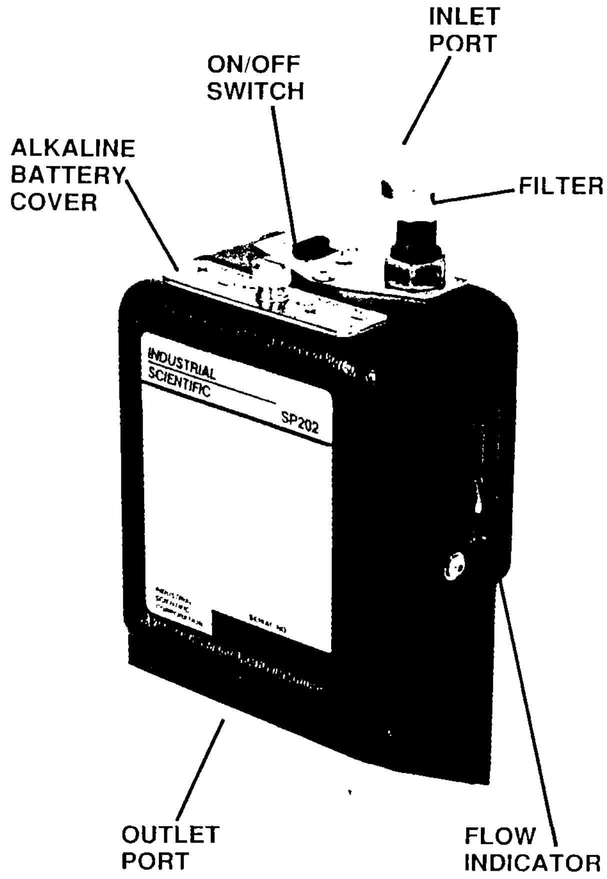

Figure 2.
SP202 Controls (Alkaline)

3.2 Testing the Pump

To test the pump for proper operation:

1. The SP202 must be held in a vertical position with the green area of the flow indicator directly above the red area. Attach desired length of tubing. Turn the pump on. The pump is working properly if the flow indicator float is in the green region. Under normal operation, the ball may be moving in the green region. If the ball is in the red region, the batteries may need charged/changed or the filter (1702-4597) may be obstructed. If the pump still does not function properly the pump must be serviced before use.

2. Block the inlet of the SP202 by placing a finger on the filter of the Sampling Pump (see Figures 1 & 2). Check the float in the flow indicator and verify that it is either fluctuating between the red and green area, or that it is completely in the red area of the indicator. Remove the obstruction from the filter of the SP202 Sampling Pump and note that the float in the flow indicator returns to the green area of the indicator.

3. Block the outlet of the SP202 by placing a finger on the outlet fitting on the Sampling Pump. Check the float in the flow indicator and verify that it is in the red area of the indicator. Remove the obstruction from the outlet of the SP202 Sampling Pump and note that the float in the flow indicator returns to the green area of the indicator.

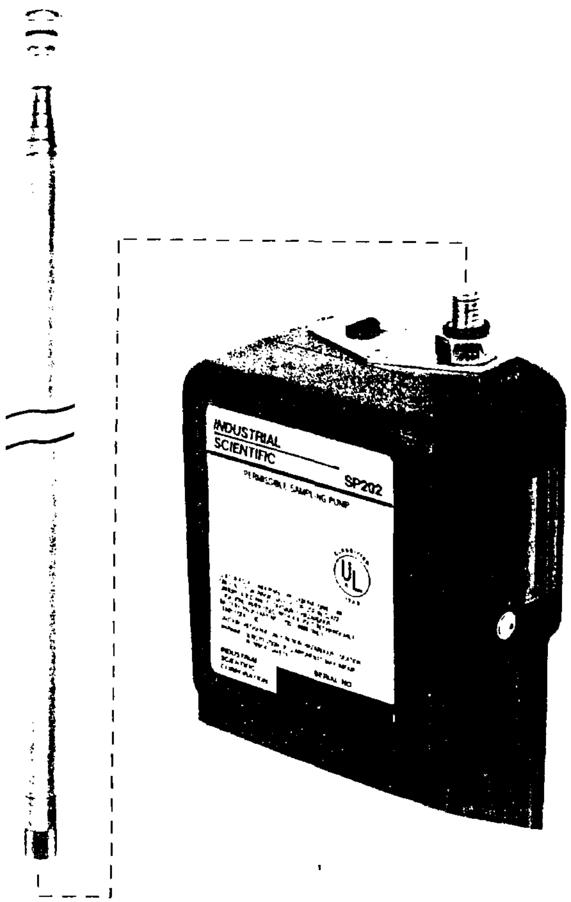

Figure 3.
SP202 with Extendable Probe

3.3 Using the Pump

NOTE: The flow indicator should be checked periodically.

To use the pump:

1. Fit the SP202 over the sensor end of the 200 Series Instrument. Push the instrument into the pump cavity as far as possible. This is a tight fit; therefore, you may need to "rock" the instrument into position. There will be gaps between the SP202 and the instrument; these serve to prevent sensor pressurization.

2. Attach the extendable probe or sampling hose on the fitting. Turn on the SP202. Allow 2 seconds per foot of hose length for the sampling line to be purged before reading the concentration.

3. If the pump motor is heard to stall or slow noticeably during use, there may be a blockage in the sample draw hose, or the external filter(s) may be clogged and need to be replaced. Check the SP202 flow indicator if a problem exists, withdraw the hose, clear the blockage and/or replace the filters, and test the unit as described in Section 3.2 before resuming operation. See Section 4.6 for the proper way to test the external filter.

3.4 Operating Precautions

1. The external dust filter will not stop mists, vapors or steam.

2. The SP202 will lift a vertical column of water in excess of 10 ft. before the pump motor will stall.

The pump will draw liquid over a much longer distance if the hose is not vertical. If liquid is drawn into the pump, internal SP202 components may be damaged (take precautions to prevent this). See Section 3.5.

3. Do not operate the SP202 without the external dust filter (P/N 1702-4597). Pump damage may result, and the warranty will be voided.

4. The screw-in external dust filter on the SP202 is designed to stop very small particles from damaging internal pump parts. In very dusty atmospheres, this filter may clog in a very short time. To prevent this, use an additional in-line prefilter, such as P/N 1701-3145 to prevent most of the dust from reaching the screw-in filter.

5. Use teflon tubing conversion kit P/N 1704-3746 when sampling for toxic gases in the parts-per-million range. Use of other tubing such as tygon can cause erroneously low readings due to the absorption of the gas by the tubing.

6. Do not use a sampling hose longer than 100 feet.

3.5 Using the Water Stop

1. A water stop is included with each pump. If the pump will be operated in areas where liquid can be drawn into the sampling hose, the water stop should be inserted into the end of the sampling hose (tapered end into hose) prior to sampling. This will prevent liquid from being drawn into the pump.

2. If the water stop is dropped into liquid, it will block the sample from entering into the hose and will

restrict sample flow. If this occurs, withdraw the hose, tap or shake the water stop to remove the liquid, and test the unit (with sample hose connected) as described in Section 3.2 before resuming operation.

3. If the pump will not operate after attempting to remove the liquid from the water stop, remove the water stop from the hose. If the flow increases, the water stop is clogged and should be replaced.

4. The water stop may also be used as an auxiliary filter in very dusty atmospheres.

4.0 MAINTENANCE

4.1 Regular Maintenance

The SP202 requires no regular maintenance except for recharging the batteries or replacing the batteries and periodic replacement of the filter.

4.2 Battery Charging (Nicad Users Only)

A completely discharged battery will be restored to full capacity by 14 hours of charging with Industrial Scientific's single-unit, five-unit, and twelve-unit chargers.

4.3 Battery "Memory" (Nicad Users Only)

An apparent reduction in battery capacity may result from repetitive use patterns. A fully charged battery should provide a minimum of 14 hours of continuous operation. A fully charged battery that does not provide 14 hours of continuous operation may have

developed a "memory" condition. To eliminate this memory:

1. Discharge the battery until the motor speed drops noticeably and the flow indicator drops into the red region. Do not discharge beyond this point.

2. Turn the pump off and recharge for a minimum of 14 hours.

3. If, after repeating this procedure one more time, the pump will not run for 14 hours, replace the battery pack.

4.4 Battery Life (Nicad)

Battery life can be maintained by the following procedure.

1. Discharge the battery to different degrees before each charging.

2. Charge the battery only when the motor begins to slow down and the flow indicator drops into the red region.

3. Never allow the battery to become fully discharged.

4.5 Battery Life (Alkaline)

A set of new batteries will provide a minimum of 10 hours of continuous operation. Actual operation time will vary between battery manufacturers, ambient temperature, and tubing length.

NOTE: Use only Industrial Scientific Corporation Part No. 1703-4265 or one of the approved battery types listed on the pump. Always replace all four alkaline batteries at the same time.

The battery cover is held in place with a quick-opening fastener. Remove the battery cover by turning the fastener in a counterclockwise direction. First, remove the batteries from positions 2 and 3. *Then, move the batteries from* positions 1 and 4 to positions 2 and 3 for removal.

To insert new batteries, the pump should be positioned face down. Insert the battery for position 1 into the pump at position 2. Then, move it to position 1. Insert the position 2 battery. Insert the battery for position 4 into the pump at position 3. Then, move it to position 4. Insert the position 3 battery. Check the exposed battery terminals against the battery cover markings for proper alignment before installing the battery cover. Press the battery cover into position and secure by turning the fastener in a clockwise direction. (see Figure 4).

4.6 Testing the SP202 Filter

To test the filter for proper operation:

1. *Switch on the pump.*
2. Listen to the pump speed.
3. Verify that the flow indicator float is in the green area.
4. Unscrew the filter (Item 11 in Fig. 5, Item 24 in Fig. 6).
5. If the pump speed increases, replace the filter.

4.7 Alternate Filter Test Method

Using the flow indicator, measure and compare the flow with first the old filter and then the new one.

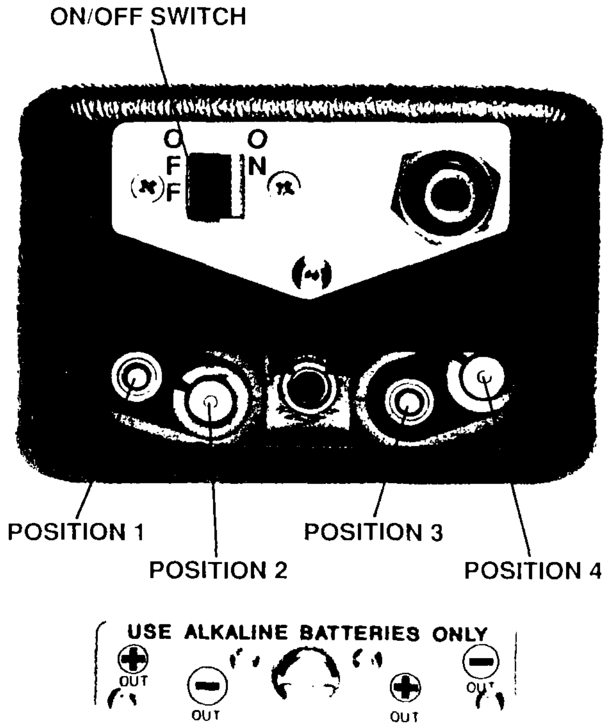

Figure 4.
Alkaline Battery Replacement

5.0 REPLACEMENT PARTS (NICAD)

The following item numbers refer to the exploded view, Figure 5.

TABLE II. REPLACEMENT PARTS

Item	Part No.	Description
	1810-1782	***SP202 SAMPLING PUMP***
1	1704-0841	Pump Assembly
2	1704-1070	Case Front
3	1704-1096	Case Back
4	1704-0585	Pump Bracket
5	1704-0544	Flow Indicator
6	1704-0601	Adapter Fitting
7	1704-1112	Faceplate
8	1704-3951	Fitting 1/8"
9	1704-0809	Switch
10	1702-4688	Battery Pack
11	1702-4597	Filter
12	1700-1660	Charging Socket
13	1701-1990	Solder Lug
14	1700-7592	Tubing
15	1703-6179	*Nut #10-32*
16	1704-0924	Nut M8 x 1.25
17	1701-3541	Screw 4-40 x 1/4"
18	1703-0693	Screw 2-56 x .25
19	1704-1682	Plate On/Off
20	1701-9795	Lockwasher
21	1704-1690	Switch Gasket
22	1702-2211	O-Ring
23	1700-5323	Wire #24 Red

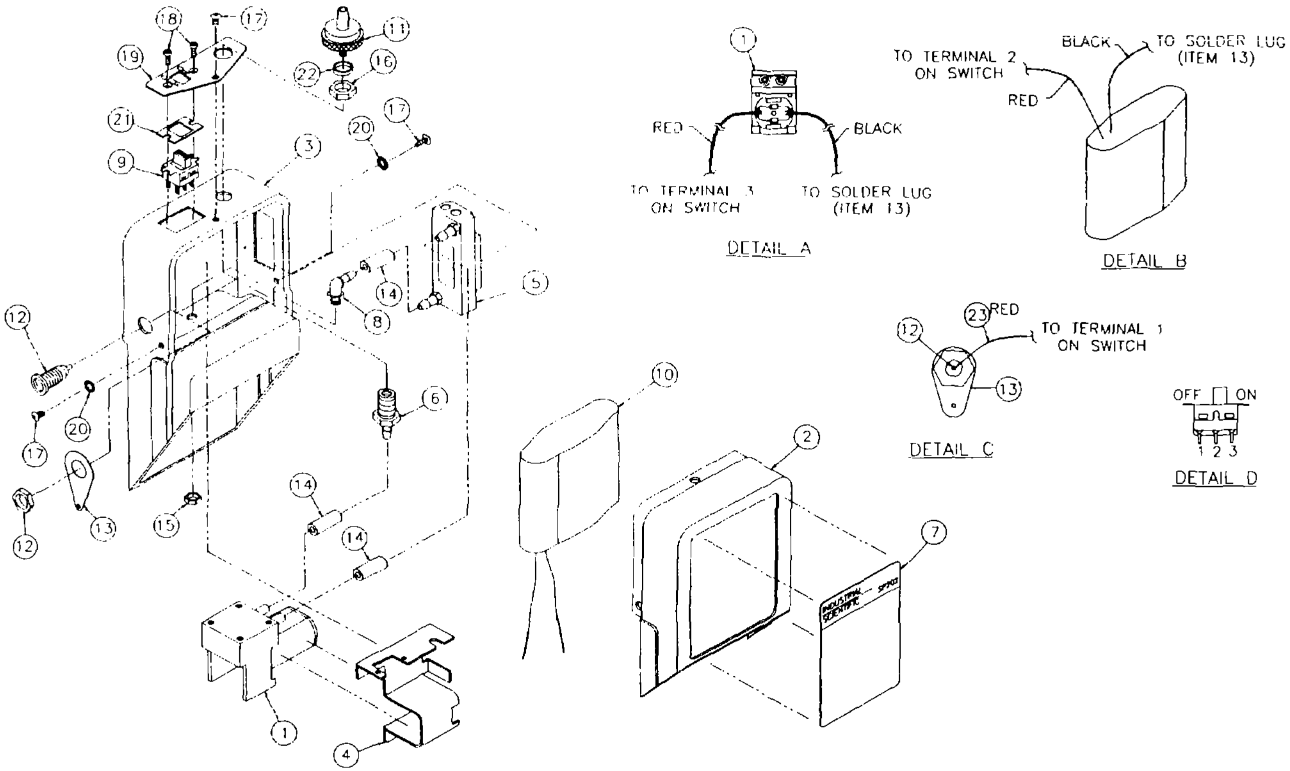

Figure 5.
Exploded View (Nicad)

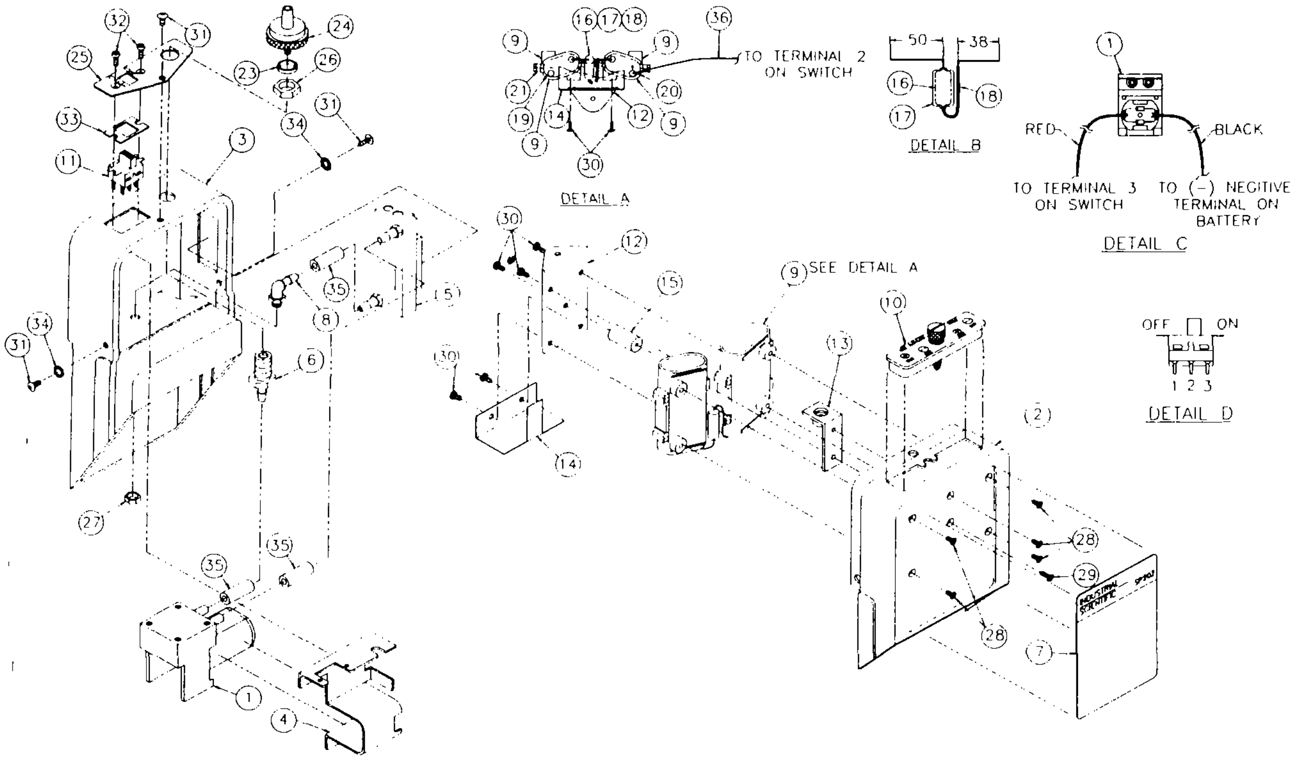

Figure 6.
Exploded View (Alkaline)

5.0 REPLACEMENT PARTS (ALKALINE)

The following item numbers refer to the exploded view, Figure 6.

TABLE III. REPLACEMENT PARTS

Item	Part No.	Description
	1810-1790	**SP202 SAMPLING PUMP**
1	1704-0841	Pump Assembly
2	1704-1062	Case Front
3	1704-1088	Case Back
4	1704-0585	Pump Bracket
5	1704-0544	Flow Indicator
6	1704-0601	Adapter Fitting
7	1704-1120	Faceplate
8	1704-3951	Fitting 1/8"
9	1703-3879	Battery Case
10	1704-0890	Battery Cover
11	1704-0809	Switch
12	1704-0577	Battery Bracket
13	1704-0916	Bracket/Fastener
14	1703-7482	Battery Insulator
15	1703-6401	Spacer
16	1703-7037	Resistor
17	1700-8715	Shrink Tubing 3/16"
18	1700-8376	Shrink Tubing 1/16"
19	1703-4182	Battery Contact (Left)
20	1703-4190	Battery Contact (Right)
21	1703-4125	Snaplock Pin
22	1703-4265	AAA Battery
23	1702-2211	O-Ring
24	1702-4597	Filter
25	1704-1682	Plate On/Off
26	1704-0924	Nut M8 x 1.25

Item	Part No.	Description
27	1703-6179	Nut #10-32
28	1703-2434	Screw 2-56 x .18
29	1703-0693	Screw 2-56 x .25
30	1703-4034	Screw 2-56 x .18 PH
31	1701-3541	Screw 4-40 x .25
32	1703-0695	Screw 2-56 x .25 PH
33	1704-1690	Switch Gasket
34	1701-9795	Lockwasher
35	1700-7592	• Tygon Tubing 1/8"
36	1700-5323	Wire #24 Red

6.0 SPECIFICATIONS

Dimensions:	52mm x 79mm x 137mm (2.04" x 3.1" x 5.4")
Weight: (Alkaline)	310 Grams (11 oz.)
(Nicad)	369 Grams (13 oz.)
Pumping Capability:	Minimum of one half liter per minute (1pm), through 100' of .125" ID hose.
Battery Life: (Nicad)	Minimum of 14 hours continuous operation with battery pack P/N 1702-4688 at 25°C with 10 ft. tygon tubing.
(Alkaline)	10 hours @ 25°C with 10 ft. tygon tubing. 2 hours @ 0° with 10 ft. tygon tubing.

7.0 SP202 ACCESSORIES

Part Number	Description
1702-4597	Screw-on filter, 1 each
1702-4191	Screw-on filter, Package of 5
1701-3145	In-line filter
1810-1386	Extendable Probe
1810-1428	4 ft. Polycarbonate Probes
1810-0123	Single-Unit Charger
1810-0115	5-Unit Charger
1810-1006	12-Unit Charger
1700-7592	Sampling Hose
1702-7152	Water Stop
1704-3746	Teflon Tubing Coversion Kit

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ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS

TABLE 7-5
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Still Bottoms/Treatment Lagoon

CHEMICAL	UNITS	CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
		MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
Acenaphthene	ug/kg	60.000	4800.000	1736.10		10
4-Nitrophenol	ug/kg	1600.000	2300.000	1950.00		2
Dibenzofuran	ug/kg	450.000	660.000	555.00		2
Diethylphthalate	ug/kg	44.000	100000.000	13281.29		24
Fluorene	ug/kg	67.000	9800.000	2692.25		12
N-Nitrosodiphenylamine	ug/kg	13000.000	13000.000	13000.00		1
4-Bromophenyl-phenylether	ug/kg	2200.000	2200.000	2200.00		1
Hexachlorobenzene	ug/kg	250.000	2800.000	982.50		4
Pentachlorophenol	ug/kg	160.000	64000.000	14024.00		15
Phenanthrene	ug/kg	79.000	10000.000	3382.13		16
Anthracene	ug/kg	74.000	3300.000	1491.33		3
Di-n-butylphthalate	ug/kg	51.000	690000.000	87654.68		28
Fluoranthene	ug/kg	66.000	1700.000	769.20		5
Pyrene	ug/kg	79.000	4700.000	1565.80		5
Butylbenzylphthalate	ug/kg	47.000	960000.000	106966.33		27
Benzo(a)anthracene	ug/kg	460.000	460.000	460.00		2
Chrysene	ug/kg	260.000	460.000	360.00		2
bis(2-Ethylhexyl)phthalate	ug/kg	140.000	2600000.000	374932.14		28
Di-n-octylphthalate	ug/kg	77.000	24000.000	5474.53		15
Benzo(b)fluoranthene	ug/kg	390.000	460.000	425.00		2
Benzo(k)fluoranthene	ug/kg	390.000	460.000	425.00		2
Benzo(a)pyrene	ug/kg	260.000	260.000	260.00		1
Pesticides/PCBs					23	
Gamma-BHC (Lindane)	ug/kg	1100.000	1100.000	1100.00		1
Endosulfan 1	ug/kg	1200.000	1200.000	1200.00		1
4,4-DDT	ug/kg	4700.000	12000.000	8350.00		2
Endrin Ketone	ug/kg	260.000	260.000	260.00		1
AROCLOR-1248	ug/kg	52000.000	76000.000	64000.00		2
AROCLOR-1254	ug/kg	28000.000	47000.000	37500.00		2
AROCLOR-1260	ug/kg	330.000	35000.000	15726.00		5
Metals					11	
Aluminum	mg/kg	490.000	7890.000	3559.09		11
Antimony	mg/kg	10.900	46.600	28.75		2
Arsenic	mg/kg	0.950	5.700	2.35		10
Barium	mg/kg	81.600	1560.000	466.08		5
Beryllium	mg/kg	0.100	0.890	0.25		10
Cadmium	mg/kg	0.120	118.000	14.73		11
Calcium	mg/kg	181.000	57100.000	11242.55		11
Chromium, Total	mg/kg	8.700	1410.000	195.72		11
Cobalt	mg/kg	41.700	41.700	41.70		1
Copper	mg/kg	6.500	361.000	72.65		11
Iron	mg/kg	482.000	6610.000	3928.36		11
Lead	mg/kg	21.900	6300.000	842.54		11

TABLE 7-5
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Still Bottoms/Treatment Lagoon

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Magnesium	mg/kg	101.000	10300.000	3419.82		11
Manganese	mg/kg	4.300	1030.000	203.30		11
Mercury	mg/kg	0.060	11.000	2.02		10
Nickel	mg/kg	12.200	19.600	16.73		3
Potassium	mg/kg	181.000	767.000	354.55		11
Selenium	mg/kg	0.460	2.830	1.42		4
Sodium	mg/kg	498.000	1260.000	757.67		3
Vanadium	mg/kg	1.200	12.100	7.43		11
Zinc	mg/kg	5.300	2280.000	359.86		11
Cyanide, Total	mg/kg	5.000	70.700	26.90		3
Percent Solids	%	63.200	90.600	80.81		11
Tent. Ident. Compound-SVOC					28	
Unknown	ug/kg	230.000	5500000.000	237468.23		198
Unknown Hydrocarbon	ug/kg	290.000	1300000.000	150781.48		61
Ethylmethylbenzene isomer	ug/kg	17000.000	1600000.000	602428.57		7
Methylbenzene + Unknown	ug/kg	11000.000	11000.000	11000.00		1
Trimethylbenzene + Unknown	ug/kg	29000.000	1800000.000	914500.00		2
Trimethylbenzene isomer	ug/kg	11000.000	1100000.000	553210.53		19
Methylpropylbenzene isomer	ug/kg	19000.000	560000.000	262833.33		6
Ethyldimethylbenzene isomer	ug/kg	9100.000	1100000.000	458131.25		16
Undecane, 4,7-dimethyl-	ug/kg	520.000	520000.000	103613.33		9
Ethyldimethylbenzene + Unknown	ug/kg	6000.000	11000.000	8500.00		2
Ethanol, 2-(2-butoxyethoxy)-...	ug/kg	17000.000	17000.000	17000.00		1
Benzene, 1,1'-oxybis-	ug/kg	280.000	100000.000	25736.00		5
Benzene, propyl-	ug/kg	490.000	280000.000	94622.50		4
Benzene, 1-ethyl-2-methyl-	ug/kg	35000.000	520000.000	258750.00		4
Benzene, 1-methyl-2-propyl-	ug/kg	440000.000	440000.000	440000.00		1
Benzene, 1,4-diethyl-	ug/kg	190000.000	510000.000	350000.00		2
Benzene, 2-ethyl-1,4-dimethyl-	ug/kg	22000.000	1900000.000	410923.08		13
Unknown + Nitrobenzene	ug/kg	900000.000	900000.000	900000.00		1
Unknown + TCL	ug/kg	1100000.000	1100000.000	1100000.00		1
Unknown Substituted Benzene	ug/kg	47000.000	1100000.000	402666.67		6
Benzene, 1-ethyl-3-methyl-	ug/kg	44000.000	1900000.000	426625.00		8
Benzene, 1,2,4-trimethyl-	ug/kg	49000.000	49000.000	49000.00		1
Benzene, (1,1-dimethylethyl)-	ug/kg	46000.000	47000.000	46500.00		2
Benzene, 2-ethyl-1,3-dimethyl-	ug/kg	42000.000	42000.000	42000.00		1
Benzene, methyl(1-methylethyl-)	ug/kg	28000.000	28000.000	28000.00		1
Unknown Alkene	ug/kg	3300000.000	3300000.000	3300000.00		1
3-Octadecene, (E)-	ug/kg	2600000.000	2600000.000	2600000.00		1
Hexadecanoic acid	ug/kg	310000.000	310000.000	310000.00		1
5-Eicosene, (E)-	ug/kg	1400000.000	1400000.000	1400000.00		1
Unknown carboxylic acid	ug/kg	43000.000	480000.000	331000.00		3
Methylpropylbenzene + Unknown	ug/kg	140000.000	1100000.000	620000.00		2
Tetramethylbenzene isomer	ug/kg	290000.000	960000.000	625000.00		2
Tetramethylbenzene + TCL	ug/kg	390000.000	1100000.000	745000.00		2
Decane	ug/kg	450.000	410000.000	216362.50		4

TABLE 7-5
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Still Bottoms/Treatment Lagoon

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Benzene, 1,3,5-trimethyl-	ug/kg	150000.000	150000.000	150000.00		1
Nonane, 2,5-dimethyl-	ug/kg	300000.000	300000.000	300000.00		1
Benzene, 1,2,3,5-tetramethyl-	ug/kg	1400.000	280000.000	140700.00		2
Tetradecane	ug/kg	670.000	140000.000	32115.71		7
Hexadecane	ug/kg	19000.000	85000.000	52000.00		2
Heptadecane, 2,6-dimethyl-	ug/kg	480.000	130000.000	68160.00		3
Dodecanoic acid	ug/kg	30000.000	30000.000	30000.00		1
Tetradecanoic acid	ug/kg	23000.000	23000.000	23000.00		1
Pentacosane	ug/kg	140000.000	140000.000	140000.00		1
Cyclohexanol, 3,3,5-trimethyl-	ug/kg	4800.000	11000.000	8500.00		3
Hexanoic acid, 2-ethyl-	ug/kg	400.000	890.000	645.00		2
Azulene, 1,2,3,3A-tetrahydro-	ug/kg	150000.000	1200000.000	675000.00		2
Diethylbenzeamine + Unknown	ug/kg	12000.000	12000.000	12000.00		1
Hexanoic acid (DOT)	ug/kg	810.000	930.000	870.00		2
Dimethylphenol	ug/kg	570.000	720.000	645.00		2
Benzene, 1,4-dimethyl-2-nitro-	ug/kg	1700.000	1700.000	1700.00		1
Sulfur, mol. (S8)	ug/kg	1600.000	7700.000	4533.33		3
Phthalic anhydride	ug/kg	4400.000	58000.000	31200.00		2
Benzenamine, n,n-diethyl-	ug/kg	890.000	140000.000	20486.25		8
Furan, 2,2'-[oxybis(methylene)]bis,-	ug/kg	440.000	440.000	440.00		1
1H-Idene, 1-ethylidene-	ug/kg	42000.000	42000.000	42000.00		1
Benzene, (1-methylethyl)-	ug/kg	180000.000	180000.000	180000.00		1
Benzene, 1,3-diethyl-4-methy...	ug/kg	870.000	870.000	870.00		1
Hydroxylamine, o-decyl-	ug/kg	590.000	140000.000	47230.00		3
Iron, tricarbonyl[n-(phenyl-...	ug/kg	140000.000	140000.000	140000.00		1
Undecane, 2-methyl-	ug/kg	100000.000	100000.000	100000.00		1
Ethanol, 2-butoxy-*	ug/kg	280000.000	280000.000	280000.00		1
Phosphoric acid, triethyles...	ug/kg	37000.000	150000.000	93500.00		2
Octanoic acid	ug/kg	370.000	4800.000	2585.00		2
2,4-Pentanediol, 2-methyl-	ug/kg	3000.000	3000.000	3000.00		1
Unknown PNA	ug/kg	13000.000	13000.000	13000.00		1
3-Octanone	ug/kg	320.000	770.000	545.00		2
Cyclohexanemethanol, .alpha.-.alpha.-4-trimethyl-	ug/kg	640.000	880.000	760.00		2
Benzene, 1,2-dimethyl-4-(phenylmethyl)-	ug/kg	31000.000	31000.000	31000.00		1
Decane, 2-Cyclohexyl-, 2-cycl...	ug/kg	140000.000	140000.000	140000.00		1
Decane, 2,6,7-trimethyl-	ug/kg	62000.000	62000.000	62000.00		1
Dimethyl undecane	ug/kg	520.000	31000.000	10986.00		5
Cyclohexanone, 3,3,5-trimethyl-	ug/kg	13000.000	65000.000	39000.00		2
Dimethyl heptadecane	ug/kg	310.000	860.000	505.00		4
Dimethyl cyclooctane	ug/kg	110000.000	110000.000	110000.00		1
VOA TCL	ug/kg	13000.000	79000.000	41666.67		3
Ethylmethylbenzene	ug/kg	120.000	360000.000	55188.95		19
Trimethylbenzene	ug/kg	320.000	100000.000	17576.36		22
Trimethylcyclohexanone	ug/kg	23000.000	23000.000	23000.00		1
Trimethylcyclohexanol	ug/kg	15000.000	15000.000	15000.00		1
Methyl(methylethyl)benzene	ug/kg	4100.000	4100.000	4100.00		1

TABLE 7-5
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Still Bottoms/Treatment Lagoon

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Ethyldimethylbenzene	ug/kg	380.000	370000.000	76224.00		10
Tetramethylbenzene	ug/kg	17000.000	47000.000	32000.00		2
Dihydromethylindene	ug/kg	8700.000	8700.000	8700.00		1
Unknown octadecenoic acid	ug/kg	13000.000	13000.000	13000.00		1
Diethylbenzene	ug/kg	91000.000	91000.000	91000.00		1
Ethyltrimethylbenzene + unknown	ug/kg	17000.000	17000.000	17000.00		1
Dimethyldodecane	ug/kg	12000.000	12000.000	12000.00		1
Methylnaphthalene	ug/kg	2000.000	13000.000	7500.00		2
Dimethylnaphthalene + unknown	ug/kg	19000.000	19000.000	19000.00		1
Tetramethylpentadecane	ug/kg	13000.000	13000.000	13000.00		1
Dimethylnaphthalene	ug/kg	1700.000	57000.000	29350.00		2
Benzene, (1,3,3-trimethylnonyl)-	ug/kg	67000.000	67000.000	67000.00		1
Benzene, 1-ethyl-2,4,5-trimethyl-	ug/kg	46000.000	46000.000	46000.00		1
Unknown benzene	ug/kg	6400.000	37000.000	22800.00		3
Unknown aromatic	ug/kg	73000.000	73000.000	73000.00		1
Methylethylbenzene	ug/kg	450.000	1400.000	925.00		2
Isoquinoline	ug/kg	620.000	780.000	700.00		2
Unknown alkyl cyclohexane	ug/kg	150000.000	150000.000	150000.00		1
Tridecane, 4,8-dimethyl-	ug/kg	35000.000	35000.000	35000.00		1
3-Pentanone, 2,2,4,4-tetram..	ug/kg	610.000	610.000	610.00		1
Cyclooctane, 2,4-dimethyl-	ug/kg	2500.000	2500.000	2500.00		1
1-Octanol, 2-butyl-	ug/kg	55000.000	55000.000	55000.00		1
Unknown oxygenated alkane	ug/kg	43000.000	43000.000	43000.00		1
Acetamide, n-ethyl-n-phenyl-	ug/kg	340.000	340.000	340.00		1
Benzenamine, n-ethyl-	ug/kg	280.000	280.000	280.00		1
Tetramethylpentanone + unknown	ug/kg	1600.000	1600.000	1600.00		1
Tetramethylbenzene + unknown	ug/kg	530.000	530.000	530.00		1
Tent. Ident. Compound-VOC					28	
Unknown	ug/kg	2600.000	1900000.000	306390.91		11
Aceticacid, butylester	ug/kg	600.000	600.000	600.00		1
Nonane	ug/kg	7900.000	200000.000	92714.29		7
Benzene, 1-ethyl-3-methyl-	ug/kg	140000.000	140000.000	140000.00		1
Octane, 2,3-dimethyl-	ug/kg	220000.000	220000.000	220000.00		1
Propylbenzene + Unknown	ug/kg	52000.000	59000.000	55500.00		2
Benzene, 1-ethyl-2-methyl-	ug/kg	130000.000	1700000.000	632500.00		4
Benzene, 1,2,4-trimethyl-	ug/kg	150000.000	1200000.000	546666.67		3
Unknown Hydrocarbon	ug/kg	390.000	1100000.000	227439.00		10
Methylethylbenzene + Unknown	ug/kg	27000.000	120000.000	73500.00		4
Heptane, 2,3,6-trimethyl-	ug/kg	230000.000	230000.000	230000.00		1
Benzene, propyl-	ug/kg	65.000	380000.000	88083.13		8
Nonane, 2,6-dimethyl-	ug/kg	250000.000	250000.000	250000.00		1
Benzene, (1-methylethyl)-	ug/kg	24000.000	480000.000	244666.67		3
Benzene, 1,2,3-trimethyl-	ug/kg	470000.000	470000.000	470000.00		1
Decane, 4-methyl-	ug/kg	120000.000	120000.000	120000.00		1
Cyclohexane, methyl-	ug/kg	58000000.000	58000000.000	58000000.000		1
Decane	ug/kg	710000.000	3200000.000	1573333.33		3

TABLE 7-5
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Still Bottoms/Treatment Lagoon

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Hexane, 3-methyl-	ug/kg	4100000.000	4100000.000	4100000.00		1
Substituted Benzene	ug/kg	790.000	420000.000	91846.25		8
Cyclohexane, ethyl-	ug/kg	100000.000	100000.000	100000.00		1
Benzene, 1,3,5-trimethyl-	ug/kg	14000.000	14000.000	14000.00		1
Octane	ug/kg	130000.000	4100000.000	2115000.00		2
Furan, tetrahydro-	ug/kg	54.000	54.000	54.00		1
Heptane, 3-methyl-	ug/kg	5900000.000	5900000.000	5900000.00		1
Benzene, (nitromethyl)-	ug/kg	250000.000	250000.000	250000.00		1
Hexane, 2-methyl-	ug/kg	3700000.000	3700000.000	3700000.00		1
Heptane	ug/kg	23000000.000	23000000.000	23000000.000		1
Cyclopentane, 1,2,4-trimethyl-	ug/kg	3300000.000	3300000.000	3300000.00		1
Cyclopentane, 1,2,3-trimethyl-	ug/kg	3200000.000	3200000.000	3200000.00		1
Hexane, 2,5-dimethyl-	ug/kg	4600000.000	4600000.000	4600000.00		1
Ethane, 1,1-dichloro-1-nitro-	ug/kg	17000.000	17000.000	17000.00		1
Methane, dichlorofluoro-	ug/kg	4800000.000	4800000.000	4800000.00		1
Nonane, 2-methyl-	ug/kg	130000.000	130000.000	130000.00		1
Methane, trichlorofluoro-	ug/kg	4200000.000	4200000.000	4200000.00		1
2-Hexanone, 5-methyl-	ug/kg	240.000	240.000	240.00		1
Ethylmethylbenzene	ug/kg	75.000	880000.000	238065.36		14
Trimethylbenzene	ug/kg	60.000	1700000.000	390309.33		15
Unknown ketone	ug/kg	7.400	7.400	7.40		1
Decane + unknown	ug/kg	1200.000	1100000.000	350700.00		6
Tetramethylbenzene	ug/kg	220000.000	1300000.000	760000.00		2
Ketone	ug/kg	57.000	230.000	143.50		2
Hydrocarbon + unknown	ug/kg	130000.000	130000.000	130000.00		1
Unknown substituted benzene	ug/kg	690000.000	690000.000	690000.00		2
Tetramethylpentanone	ug/kg	56.000	56.000	56.00		1
Unknown hydrocarbon C10H22	ug/kg	270000.000	270000.000	270000.00		1
Ethylmethylheptane + unknown	ug/kg	330000.000	330000.000	330000.00		1
Methylnonane	ug/kg	7900.000	7900.000	7900.00		1
Undecane + unknown	ug/kg	510000.000	510000.000	510000.00		1
Ethyldimethylbenzene	ug/kg	120000.000	760000.000	440000.00		2
Trimethyloctane	ug/kg	4300.000	4300.000	4300.00		1
Ethane, 1,1,2-trichloro-1,2,2-trichloro-trifluoroethane	ug/kg	670000.000	670000.000	670000.00		1
Methylphenylethanone	ug/kg	160000.000	160000.000	160000.00		1

This table includes all compounds identified above detection limits in the Stillbottoms/Treatment Lagoon Area (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Volatiles					44	
Vinyl Chloride	ug/kg	2900.000	2900.000	2900.00		1
Chloroethane	ug/kg	8.000	2000.000	949.33		3
Methylene Chloride	ug/kg	120.000	210000.000	31462.22		9
Acetone	ug/kg	18.000	34000000.000	1549406.00		23
1,1-Dichloroethene	ug/kg	3.000	390000.000	117348.25		4
1,1-Dichloroethane	ug/kg	2.000	490000.000	56253.28		18
Total 1,2-Dichloroethene	ug/kg	2.000	34000.000	5551.64		14
Chloroform	ug/kg	2.000	2800000.000	222572.21		19
1,2-Dichloroethane	ug/kg	19.000	440000.000	34581.56		16
2-Butanone	ug/kg	9.000	99000000.000	3760304.09		35
1,1,1-Trichloroethane	ug/kg	6.000	150000000.000	5679486.07		29
1,2-Dichloropropane	ug/kg	1.000	23000.000	3037.36		11
Trichloroethene	ug/kg	3.000	19000000.000	926650.18		33
1,1,2-Trichloroethane	ug/kg	630.000	400000.000	94626.00		5
Benzene	ug/kg	5.000	1500000.000	97320.92		36
4-Methyl-2-Pentanone	ug/kg	1400.000	61000000.000	2535958.62		29
2-Hexanone	ug/kg	11.000	47000.000	12348.71		7
Tetrachloroethene	ug/kg	4.000	46000000.000	2161008.94		35
1,1,2,2-Tetrachloroethane	ug/kg	17.000	17.000	17.00		1
Toluene	ug/kg	5.000	130000000.000	3957498.77		44
Chlorobenzene	ug/kg	3.000	1000000.000	176792.17		6
Ethylbenzene	ug/kg	2.000	23000000.000	942758.29		41
Styrene	ug/kg	30.000	310000.000	86604.29		7
Total Xylenes	ug/kg	2.000	100000000.000	3734752.63		43
Semi-Volatiles					35	
Phenol	ug/kg	85.000	860000.000	84403.00		25
bis(2-Chloroethyl)ether	ug/kg	150.000	200000.000	48040.67		15
1,4-Dichlorobenzene	ug/kg	46.000	11000.000	3146.27		11
Benzyl alcohol	ug/kg	89.000	34000.000	4163.90		10
1,2-Dichlorobenzene	ug/kg	80.000	120000.000	18266.47		19
2-Methylphenol	ug/kg	420.000	90000.000	15494.58		24
4-Methylphenol	ug/kg	150.000	210000.000	33741.07		28
Isophorone	ug/kg	98.000	3600000.000	443152.07		28
2,4-Dimethylphenol	ug/kg	250.000	220000.000	26390.40		25
Benzoic acid	ug/kg	230.000	32000000.000	2293735.33		15
2,4-Dichlorophenol	ug/kg	57.000	200.000	107.33		3
1,2,4-Trichlorobenzene	ug/kg	54.000	79000.000	13469.33		9
Naphthalene	ug/kg	230.000	2400000.000	282228.00		30
Hexachlorobutadiene	ug/kg	190.000	150000.000	33025.00		8
2-Methylnaphthalene	ug/kg	43.000	990000.000	147837.00		29
Dimethylphthalate	ug/kg	120.000	710000.000	68395.65		23
Acenaphthylene	ug/kg	57.000	11000.000	3694.25		4
2,6-Dinitrotoluene	ug/kg	3500.000	3500.000	3500.00		1

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Acenaphthene	ug/kg	68.000	18000.000	5258.36		14
4-Nitrophenol	ug/kg	10000.000	10000.000	10000.00		1
Dibenzofuran	ug/kg	59.000	11000.000	3241.73		11
Diethylphthalate	ug/kg	60.000	280000.000	24047.17		24
Fluorene	ug/kg	58.000	28000.000	7737.80		15
N-Nitrosodiphenylamine	ug/kg	180.000	53000.000	11060.00		8
Hexachlorobenzene	ug/kg	930.000	11000.000	5965.00		2
Pentachlorophenol	ug/kg	180.000	180000.000	44296.00		10
Phenanthrene	ug/kg	39.000	43000.000	8514.70		20
Anthracene	ug/kg	230.000	1300.000	910.00		3
Di-n-butylphthalate	ug/kg	54.000	3400000.000	327294.50		30
Fluoranthene	ug/kg	220.000	19000.000	4418.33		12
Pyrene	ug/kg	330.000	22000.000	6426.00		10
Butylbenzylphthalate	ug/kg	72.000	1600000.000	185039.24		29
Benzo(a)anthracene	ug/kg	360.000	14000.000	3738.33		6
Chrysene	ug/kg	400.000	20000.000	5316.67		6
bis(2-Ethylhexyl)phthalate	ug/kg	180.000	14000000.000	1525888.93		28
Di-n-octylphthalate	ug/kg	72.000	140000.000	15918.20		15
Benzo(b)fluoranthene	ug/kg	220.000	15000.000	4816.00		5
Benzo(k)fluoranthene	ug/kg	220.000	15000.000	4816.00		5
Benzo(a)pyrene	ug/kg	380.000	9700.000	3245.00		4
Indeno(1,2,3-cd)pyrene	ug/kg	420.000	1400.000	790.00		3
Dibenz(a,h)anthracene	ug/kg	70.000	190.000	130.00		2
Benzo(g,h,i)perylene	ug/kg	230.000	1500.000	766.67		3
Pesticides/PCBs					44	
Alpha-BHC	ug/kg	330.000	330.000	330.00		1
Beta-BHC	ug/kg	800.000	800.000	800.00		1
Aldrin	ug/kg	13.000	7700.000	3856.50		2
Heptachlor Epoxide	ug/kg	13.000	13.000	13.00		1
4,4-DDE	ug/kg	880.000	880.000	880.00		1
4,4-DDD	ug/kg	3300.000	3300.000	3300.00		1
4,4-DDT	ug/kg	1700.000	1700.000	1700.00		1
AROCLOR-1242	ug/kg	96.000	190000.000	66265.33		3
AROCLOR-1248	ug/kg	16000.000	35000.000	23666.67		3
AROCLOR-1254	ug/kg	210.000	650000.000	62715.33		15
AROCLOR-1260	ug/kg	200.000	560000.000	81630.83		12
Metals					19	
Aluminum	mg/kg	137.000	18000.000	4453.00		19
Antimony	mg/kg	3.700	152.000	46.24		5
Arsenic	mg/kg	1.100	9.100	3.33		17
Barium	mg/kg	67.400	6400.000	1461.68		5
Beryllium	mg/kg	0.060	0.800	0.21		16
Cadmium	mg/kg	0.060	1700.000	102.19		18
Calcium	mg/kg	413.000	50500.000	19413.94		17

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Chromium, Total	mg/kg	6.600	3750.000	253.42		18
Cobalt	mg/kg	14.600	69.100	29.62		5
Copper	mg/kg	5.600	5790.000	415.01		18
Iron	mg/kg	2670.000	27400.000	8202.11		19
Lead	mg/kg	2.300	17200.000	1066.82		19
Magnesium	mg/kg	394.000	18800.000	8300.31		13
Manganese	mg/kg	13.400	441.000	136.50		19
Mercury	mg/kg	0.120	36.000	5.15		8
Nickel	mg/kg	10.900	72.600	34.33		8
Potassium	mg/kg	34.900	8100.000	1081.63		19
Selenium	mg/kg	1.200	157.000	33.56		5
Silver	mg/kg	312.000	312.000	312.00		1
Sodium	mg/kg	232.000	2410.000	704.80		5
Thallium	mg/kg	0.720	1.500	1.07		3
Vanadium	mg/kg	4.500	24.300	11.42		17
Zinc	mg/kg	7.800	4700.000	458.22		19
Cyanide, Total	mg/kg	7.100	31.300	14.28		4
Percent Solids	%	46.400	91.000	78.35		19
Tent. Ident. Compound-SVOC					35	
Unknown	ug/kg	120.000	100000000.000	1118379.22		281
Unknown Hydrocarbon	ug/kg	270.000	1100000.000	88402.88		66
Ethylmethylbenzene isomer	ug/kg	70000.000	84000.000	77000.00		2
Trimethylbenzene + Unknown	ug/kg	220000.000	220000.000	220000.00		1
Trimethylbenzene isomer	ug/kg	86000.000	1900000.000	775750.00		8
Ethyldimethylbenzene isomer	ug/kg	65000.000	1300000.000	749166.67		6
Undecane, 4,7-dimethyl-	ug/kg	1200.000	1100000.000	279890.91		11
Ethyldimethylbenzene + Unknown	ug/kg	830000.000	830000.000	830000.00		1
Ethanol, 2-(2-butoxyethoxy)-...	ug/kg	3800.000	3800.000	3800.00		1
Methanol, dibutoxy-	ug/kg	2400000.000	2400000.000	2400000.00		1
Benzene, 1,1'-oxybis-	ug/kg	2800.000	3500000.000	454366.67		12
Benzene, propyl-	ug/kg	380000.000	520000.000	450000.00		2
Benzene, 1-ethyl-2-methyl-	ug/kg	2800.000	1600000.000	627600.00		3
Benzene, 1,4-diethyl-	ug/kg	750000.000	750000.000	750000.00		1
Benzene, 2-ethyl-1,4-dimethyl-	ug/kg	1700.000	650000.000	233375.00		4
Unknown Substituted Benzene	ug/kg	580.000	780000.000	390290.00		2
Benzene, 1-ethyl-3-methyl-	ug/kg	5700.000	1900000.000	781900.00		3
Benzene, 1,2,4-trimethyl-	ug/kg	1100.000	620000.000	310550.00		2
Benzene, 2-ethyl-1,3-dimethyl-	ug/kg	1700.000	1700.000	1700.00		1
Benzene, methyl(1-methylethyl-)	ug/kg	330000.000	330000.000	330000.00		1
Hexadecanoic acid	ug/kg	2800000.000	2800000.000	2800000.00		1
Unknown carboxylic acid	ug/kg	500.000	1600.000	1050.00		2
Tetramethylbenzene isomer	ug/kg	280000.000	280000.000	280000.00		1
Decane	ug/kg	89000.000	440000.000	224750.00		4
Benzene, 1,3,5-trimethyl-	ug/kg	2900.000	1300000.000	375280.00		5
Nonane, 2,5-dimethyl-	ug/kg	91000.000	1600000.000	672750.00		4

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Tetradecane	ug/kg	20000.000	78000.000	45333.33		3
Hexadecane	ug/kg	82000.000	82000.000	82000.00		1
Heptadecane, 2,6-dimethyl-	ug/kg	280.000	42000.000	10750.00		4
Heptadecane	ug/kg	16000.000	16000.000	16000.00		1
Docosane	ug/kg	3900.000	3900.000	3900.00		1
Cyclohexanol, 3,3,5-trimethyl-	ug/kg	9500.000	13000.000	10875.00		4
Nonane, 2,6-dimethyl-	ug/kg	82000.000	2300000.000	808000.00		4
Benzene, 1-methyl-3-propyl-	ug/kg	360000.000	700000.000	530000.00		2
Azulene, 1,2,3,3A-tetrahydro-	ug/kg	470000.000	470000.000	470000.00		1
Diethylbenzeamine + Unknown	ug/kg	990000.000	990000.000	990000.00		1
Hexanoic acid (DOT)	ug/kg	1100.000	3700.000	2200.00		3
Dimethylphenol + Unknown	ug/kg	1100.000	1100.000	1100.00		1
Dimethylphenol	ug/kg	280.000	54000.000	9075.71		14
Benzene, 1,4-dimethyl-2-nitro-	ug/kg	5300.000	5300.000	5300.00		1
Unknown chlorinated compound	ug/kg	13000.000	98000.000	55500.00		2
Unknown fatty acid	ug/kg	2600000.000	2600000.000	2600000.00		1
2-Butenedioic acid (E)-dim...	ug/kg	15000000.000	15000000.000	15000000.000		1
Butanedioicacid, dimethyle...	ug/kg	4700000.000	4700000.000	4700000.00		1
Butanedioicacid, monomethyl..	ug/kg	63000000.000	63000000.000	63000000.000		1
1,3-Propanediol, 2,2-dimethyl-	ug/kg	2600000.000	2600000.000	2600000.00		1
Hexanedioic acid, ethylmethlester-	ug/kg	1600000.000	1600000.000	1600000.00		1
Hexanedioic acid, dibutylester	ug/kg	7100000.000	7100000.000	7100000.00		1
Hexanedioic acid, bis(2-methylpropyl) ester-	ug/kg	9600000.000	9600000.000	9600000.00		1
Benzene, 2,4-dimethyl-1-(1-methylethyl)-	ug/kg	2300.000	940000.000	471150.00		2
Cyclopentanol, 2-methyl-CI...	ug/kg	2600.000	2600.000	2600.00		1
Cyclopropanamine, 2-phenyl-,...	ug/kg	9600.000	9600.000	9600.00		1
Phenol, 2,3-dimethyl-	ug/kg	3000.000	11000.000	6475.00		4
Benzene, 1-methyl-4-(1-methylethyl)-	ug/kg	6100.000	6100.000	6100.00		1
Benzene, 1-methyl-3-(1-methylethyl)-	ug/kg	1100.000	1100.000	1100.00		1
Benzene, 1-ethyl-4-methoxy-	ug/kg	1800.000	1800.000	1800.00		1
Cyclopentene, 1-ethenyl-3-me...	ug/kg	180000.000	220000.000	200000.00		2
Dimethylbenzene isomer	ug/kg	120000.000	120000.000	120000.00		1
Butylcitrate + Unknown	ug/kg	430000.000	430000.000	430000.00		1
Benzenamine, n,n-diethyl-	ug/kg	300.000	530000.000	274575.00		4
1,4-Methanonaphthalene, 1,4-...	ug/kg	55000.000	55000.000	55000.00		1
Benzaldehyde, 4-propyl-	ug/kg	78000.000	510000.000	276000.00		3
Naphthalene, 1-methyl-	ug/kg	78000.000	730000.000	397000.00		4
Dispiro[2.0.2.2]octane	ug/kg	40000.000	40000.000	40000.00		1
Benzene, 1,3-diethyl-4-methy...	ug/kg	69000.000	69000.000	69000.00		1
Benzene, 1,2,3-trimethyl-	ug/kg	7600.000	7600.000	7600.00		1
Ethanol, 2-[2-(2-ethoxyethox...	ug/kg	1700.000	1700.000	1700.00		1
Ethanol, 1-(2-butoxyethoxy)-	ug/kg	18000.000	18000.000	18000.00		1
Phenol, 2-ethyl-4-methyl	ug/kg	460.000	2500.000	1586.67		3
Iron, tricarbonyl[n-(phenyl-...	ug/kg	47000.000	47000.000	47000.00		1
Ethanol, 2-butoxy-*	ug/kg	430.000	2900.000	1665.00		2

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Phosphoric acid, triethyles...	ug/kg	230000.000	230000.000	230000.00		1
Octanoic acid	ug/kg	2000.000	2000.000	2000.00		1
2,4-Pentanediol, 2-methyl-	ug/kg	1100.000	7500.000	3660.00		5
3-Octanone	ug/kg	910.000	910.000	910.00		1
Cyclohexanemethanol, .alpha.-.alpha.-4-trimethyl-	ug/kg	320.000	320.000	320.00		1
Unknown substituted phenol	ug/kg	780.000	780.000	780.00		1
1,2-Benzenedicarboxylic acid butyl-2-methyl	ug/kg	78000.000	78000.000	78000.00		1
Unknown phthalate	ug/kg	1800.000	1200000.000	222300.00		6
Dimethyl undecane	ug/kg	72000.000	91000.000	81500.00		2
Methylethylphenol	ug/kg	330.000	2500.000	1392.50		4
Unknown alcohol	ug/kg	580.000	16000.000	8290.00		2
Cyclohexanone, 3,3,5-trimethyl-	ug/kg	2100.000	17000.000	9550.00		2
Phenol, 3-propyl-	ug/kg	660.000	660.000	660.00		1
Ethylmethylbenzene	ug/kg	630.000	2100000.000	588203.75		8
Trimethylbenzene	ug/kg	550.000	1400000.000	353965.91		22
Trimethylcyclohexanol	ug/kg	5400.000	5400.000	5400.00		1
Ethyldimethylbenzene	ug/kg	35000.000	1700000.000	731500.00		10
Tetramethylbenzene	ug/kg	250.000	290000.000	110750.00		3
Diethylbenzene	ug/kg	1500.000	2200000.000	1100750.00		2
Unknown alkylated benzene	ug/kg	88000.000	280000.000	159666.67		6
Dimethylnonane	ug/kg	140000.000	140000.000	140000.00		1
Methylpropylbenzene	ug/kg	98000.000	140000.000	119000.00		2
Urea, n-methyl-n'-(4-methylphenyl)-	ug/kg	1800.000	1800.000	1800.00		1
Methylethylbenzene + unknown	ug/kg	830.000	830.000	830.00		1
Benzopyrene	ug/kg	270.000	270.000	270.00		1
Methylnaphthalene	ug/kg	230000.000	230000.000	230000.00		1
Unknown benzene	ug/kg	130000.000	480000.000	285000.00		4
Unknown aromatic	ug/kg	37000.000	1400000.000	406500.00		4
7-Hexadecane, (z)-	ug/kg	73000.000	73000.000	73000.00		1
3-Hexadecane, (z)-	ug/kg	1300.000	1300.000	1300.00		1
2-Methylcyclopentanol	ug/kg	510.000	1200.000	855.00		2
9-Octadecene, (E)-	ug/kg	970.000	1200.000	1085.00		2
Unknown substituted hydrocarbon	ug/kg	1100.000	510000.000	195525.00		4
Silanediamine, 1,1-dimethyl-	ug/kg	340000.000	340000.000	340000.00		1
1-Hexen-3-one, 5-methyl-1-phenyl-	ug/kg	80000.000	80000.000	80000.00		1
Azobenzene (ACN)	ug/kg	120000.000	120000.000	120000.00		1
Benzeneacetonitrile, .alpha...	ug/kg	120000.000	120000.000	120000.00		1
Phenol, 2-ethyl-5-methyl-	ug/kg	3400.000	3400.000	3400.00		1
Benzenamine, n-methyl-	ug/kg	930.000	930.000	930.00		1
Methylethylbenzene	ug/kg	1700.000	2300.000	2000.00		2
Diethylbenzene + unknown	ug/kg	400000.000	400000.000	400000.00		1
Diethylundecane	ug/kg	440000.000	440000.000	440000.00		1
Acetic acid, 2-ethylhexyl ester	ug/kg	350000.000	350000.000	350000.00		1
Methylmethylethylbenzene + unknown	ug/kg	290000.000	290000.000	290000.00		1
Unknown ethoxyl alcohol	ug/kg	6500.000	6500.000	6500.00		1
Ethanone, 1-phenyl-	ug/kg	2100.000	2100.000	2100.00		1
1-Decanol, 2-ethyl-	ug/kg	3100.000	3100.000	3100.00		1

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Isoquinoline	ug/kg	4900.000	4900.000	4900.00		1
Unknown Ketone	ug/kg	2100.000	2100.000	2100.00		1
Unknown butoxyethoxy ethanol	ug/kg	2100.000	2100.000	2100.00		1
Unknown substituted alkane	ug/kg	9600.000	9600.000	9600.00		1
Cyclohexane, 1,2,4,5-tetraethyl-	ug/kg	2500.000	2500.000	2500.00		1
Tent. Ident. Compound-VOC					44	
Unknown	ug/kg	130.000	1500000.000	192115.48		31
Aceticacid, butylester	ug/kg	22.000	140000.000	30555.60		5
Nonane	ug/kg	32.000	160000.000	53340.80		15
Benzene, 1-ethyl-3-methyl-	ug/kg	300000.000	300000.000	300000.00		1
Octane, 2,3-dimethyl-	ug/kg	1700.000	97000.000	52233.33		3
Propylbenzene + Unknown	ug/kg	3100.000	200000.000	64820.00		5
Benzene, 1-ethyl-2-methyl-	ug/kg	65000.000	910000.000	329000.00		5
Benzene, 1,2,4-trimethyl-	ug/kg	150000.000	150000.000	150000.00		1
Unknown Hydrocarbon	ug/kg	11000.000	280000.000	124000.00		10
Methylethylbenzene + Unknown	ug/kg	24.000	640000.000	136990.57		7
Benzene, propyl-	ug/kg	17000.000	160000.000	69857.14		7
Nonane, 2,6-dimethyl-	ug/kg	2000.000	130000.000	41250.00		4
Benzene, (1-methylethyl)-	ug/kg	190000.000	190000.000	190000.00		1
Benzene, 1,2,3-trimethyl-	ug/kg	380000.000	380000.000	380000.00		1
Ethylmethylbenzene isomer	ug/kg	1100.000	370000.000	125775.00		4
Trimethylbenzene isomer	ug/kg	860.000	690000.000	252382.50		8
Decane	ug/kg	2700.000	580000.000	280242.86		7
Cyclopentane, 1-ethyl-3-methyl-, cis-	ug/kg	7500.000	7500.000	7500.00		1
Substituted Benzene	ug/kg	2000.000	15000.000	7240.00		5
3-Pentanone, 2,2,4,4-tetramethyl-	ug/kg	13.000	13.000	13.00		1
Trimethylbenzene + Unknown	ug/kg	2700.000	100000.000	44566.67		3
Nonane, 4-methyl-	ug/kg	5200.000	5200.000	5200.00		1
2-Pentanol, 4-methyl-	ug/kg	390.000	390.000	390.00		1
Undecane	ug/kg	1300000.000	1300000.000	1300000.00		1
Aceticacid, methylester	ug/kg	270000.000	270000.000	270000.00		1
Octane	ug/kg	170.000	27000.000	13585.00		2
Hexane, 4-ethyl-2-methyl-	ug/kg	60000.000	60000.000	60000.00		1
Heptane, 2,3,5-trimethyl-	ug/kg	54000.000	54000.000	54000.00		1
Methane, oxybis-	ug/kg	27000.000	27000.000	27000.00		1
Methane, dimethoxy-	ug/kg	92000.000	92000.000	92000.00		1
3-Buten-2-one, 3-methyl-	ug/kg	100000.000	100000.000	100000.00		1
1-Butanol	ug/kg	2500.000	480000.000	241250.00		2
Pentane	ug/kg	4600.000	120000.000	62300.00		2
2,3-Heptadien-5-yne, 2,4-dimethyl-	ug/kg	140000.000	140000.000	140000.00		1
Benzene, (2-methylpropyl)-	ug/kg	98000.000	98000.000	98000.00		1
Unknown alcohol	ug/kg	380.000	1700.000	1040.00		2
Furan, tetrahydro-	ug/kg	91.000	310.000	188.75		4
3-Heptanone, 5-methyl-	ug/kg	15.000	15.000	15.00		1
1-Propenylbenzene + Unknown	ug/kg	120000.000	120000.000	120000.00		1

TABLE 7-6
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Off-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Heptane, 3-methyl-	ug/kg	5300.000	5300.000	5300.00		1
Hexane, 2,2,3,3-tetramethyl-	ug/kg	6000.000	6000.000	6000.00		1
Cyclohexane, butyl-	ug/kg	52000.000	52000.000	52000.00		1
Heptane	ug/kg	180.000	180.000	180.00		1
2-Hexanone, 5-methyl-	ug/kg	20.000	20.000	20.00		1
Ethane, 1,1'oxybis-	ug/kg	22.000	57.000	39.50		2
Propanoicacid, 2-methyl-,butylester-	ug/kg	27000.000	27000.000	27000.00		1
Unknown oxygenated alkane	ug/kg	71.000	71.000	71.00		1
Ethenylcyclohexene	ug/kg	3700.000	3700.000	3700.00		1
Ethylmethylbenzene	ug/kg	9.400	5900000.000	257982.09		39
Trimethylbenzene	ug/kg	4.700	9800000.000	402142.25		41
Unknown ketone	ug/kg	20.000	440.000	136.75		4
Decane + unknown	ug/kg	16.000	1500000.000	263772.57		14
Ethylmethylheptane	ug/kg	58000.000	91000.000	74500.00		2
Methyl(methylethyl) benzene	ug/kg	210000.000	210000.000	210000.00		1
Tetramethylbenzene	ug/kg	11000.000	91000.000	51000.00		2
Unknown substituted benzene	ug/kg	4400.000	96000.000	50200.00		2
Methylheptanone	ug/kg	6.000	6.000	6.00		1
Dimethylnonane + unknown	ug/kg	110000.000	110000.000	110000.00		1
Unknown Hydrocarbon C10H16	ug/kg	130.000	130.000	130.00		1
Bicyclo[3.1.0]hex-2-ene, 2-methyl-	ug/kg	29000.000	29000.000	29000.00		1
Methylnonane	ug/kg	6800.000	20000.000	13400.00		2
Dimethylnonane	ug/kg	87000.000	87000.000	87000.00		1
Decane + Substituted benzene	ug/kg	8800000.000	8800000.000	8800000.00		1
Undecane + Substituted benzene	ug/kg	9800000.000	9800000.000	9800000.00		1
Acetic acid, 1-methylethylester	ug/kg	31.000	640000.000	160801.75		4
Undecane + unknown	ug/kg	210000.000	210000.000	210000.00		1
Acetic acid ester	ug/kg	100000.000	100000.000	100000.00		1
2-Propanol	ug/kg	1900.000	3100.000	2500.00		2
Butanol	ug/kg	51.000	610.000	323.67		3
Unknown oxygenated hydrocarbon	ug/kg	450.000	450.000	450.00		1
Hexanol	ug/kg	14.000	14.000	14.00		1
Methylhexanol	ug/kg	19.000	30.000	24.50		2
Ethyldimethylbenzene	ug/kg	8200.000	8200.000	8200.00		1
Hexane	ug/kg	150.000	150.000	150.00		1
Pentanol	ug/kg	110.000	110.000	110.00		1
Propenylbenzene + unknown	ug/kg	7300.000	7300.000	7300.00		1
Trimethyltricycloheptane	ug/kg	99000.000	99000.000	99000.00		1
Acetic acid, propylester	ug/kg	39.000	39.000	39.00		1
Octane, 2,6-dimethyl-	ug/kg	5300.000	5300.000	5300.00		1
Benzene, 1,1'-oxybis-	ug/kg	7300.000	7300.000	7300.00		1

This table includes all compounds identified above detection limits in the Off-Site Containment Area (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

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TABLE 7-7
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Surface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Volatiles					4	
Methylene Chloride	ug/kg	200.000	200.000	200.00		1
Acetone	ug/kg	130.000	970.000	550.00		2
1,1-Dichloroethane	ug/kg	86.000	150.000	118.00		2
Total 1,2-Dichloroethene	ug/kg	21.000	7600.000	3810.50		2
Chloroform	ug/kg	10.000	10.000	10.00		1
1,1,1-Trichloroethane	ug/kg	9.000	9.000	9.00		1
1,2-Dichloropropane	ug/kg	19.000	19.000	19.00		1
Trichloroethene	ug/kg	11.000	170000.000	90003.67		3
Benzene	ug/kg	320.000	3200.000	1760.00		2
4-Methyl-2-Pentanone	ug/kg	270000.000	270000.000	270000.00		1
Tetrachloroethene	ug/kg	130.000	790000.000	260092.50		4
Toluene	ug/kg	29000.000	19000000.000	6556333.33		3
Chlorobenzene	ug/kg	6200.000	6200.000	6200.00		1
Ethylbenzene	ug/kg	7000.000	4300000.000	1482333.33		3
Styrene	ug/kg	23000.000	23000.000	23000.00		1
Total Xylenes	ug/kg	5900.000	23000000.000	5904975.00		4
Semi-Volatiles					4	
Phenol	ug/kg	190.000	28000.000	8822.50		4
1,2-Dichlorobenzene	ug/kg	200.000	590.000	395.00		2
2-Methylphenol	ug/kg	4700.000	4700.000	4700.00		1
4-Methylphenol	ug/kg	230.000	4600.000	2415.00		2
Isophorone	ug/kg	840.000	97000.000	36560.00		4
2,4-Dimethylphenol	ug/kg	1300.000	4900.000	3100.00		2
Naphthalene	ug/kg	680.000	97000.000	33895.00		4
2-Methylnaphthalene	ug/kg	460.000	56000.000	19740.00		4
2,4,5-Trichlorophenol	ug/kg	170.000	170.000	170.00		1
Dimethylphthalate	ug/kg	1400.000	1400.000	1400.00		1
Acenaphthene	ug/kg	360.000	360.000	360.00		1
Dibenzofuran	ug/kg	360.000	430.000	395.00		2
Diethylphthalate	ug/kg	150.000	5000.000	2575.00		2
Fluorene	ug/kg	470.000	620.000	566.67		3
N-Nitrosodiphenylamine	ug/kg	1900.000	4300.000	3100.00		2
Pentachlorophenol	ug/kg	1500.000	1500.000	1500.00		1
Phenanthrene	ug/kg	450.000	4300.000	2150.00		4
Anthracene	ug/kg	660.000	660.000	660.00		1
Di-n-butylphthalate	ug/kg	11000.000	94000.000	36000.00		4
Fluoranthene	ug/kg	760.000	3400.000	2080.00		2
Pyrene	ug/kg	1300.000	2300.000	1800.00		2
Butylbenzylphthalate	ug/kg	3200.000	51000.000	23733.33		3
Benzo(a)anthracene	ug/kg	850.000	2400.000	1625.00		2
Chrysene	ug/kg	1300.000	1300.000	1300.00		2
bis(2-Ethylhexyl)phthalate	ug/kg	110000.000	540000.000	342500.00		4
Di-n-octylphthalate	ug/kg	1300.000	38000.000	15800.00		3
Benzo(b)fluoranthene	ug/kg	430.000	3900.000	2165.00		2

TABLE 7-7
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Surface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Benzo(k)fluoranthene	ug/kg	430.000	3900.000	2165.00		2
Benzo(a)pyrene	ug/kg	1400.000	1400.000	1400.00		1
Indeno(1,2,3-cd)pyrene	ug/kg	820.000	820.000	820.00		1
Dibenz(a,h)anthracene	ug/kg	270.000	270.000	270.00		1
Benzo(g,h,i)perylene	ug/kg	1100.000	1100.000	1100.00		1
Pesticides/PCBs					16	
Aldrin	ug/kg	88.000	88.000	88.00		1
Endosulfan 1	ug/kg	42.000	42.000	42.00		1
4,4-DDD	ug/kg	25.000	150.000	77.67		3
AROCLOR-1242	ug/kg	15000.000	280000.000	89750.00		4
AROCLOR-1248	ug/kg	5100.000	27000.000	13333.33		3
AROCLOR-1254	ug/kg	2000.000	22000.000	12360.00		5
Metals					4	
Aluminum	mg/kg	3220.000	13200.000	7667.50		4
Antimony	mg/kg	9.000	84.800	49.63		4
Arsenic	mg/kg	2.100	30.600	10.28		4
Barium	mg/kg	107.000	5730.000	2519.25		4
Beryllium	mg/kg	0.160	1.500	0.53		4
Cadmium	mg/kg	5.000	174.000	114.00		4
Calcium	mg/kg	2910.000	157000.000	50227.50		4
Chromium, Total	mg/kg	70.000	3080.000	1327.25		4
Cobalt	mg/kg	42.300	148.000	82.40		3
Copper	mg/kg	176.000	4470.000	1553.75		4
Iron	mg/kg	8220.000	70100.000	25060.00		4
Lead	mg/kg	401.000	16200.000	8277.75		4
Magnesium	mg/kg	2260.000	36900.000	16326.67		3
Manganese	mg/kg	135.000	1540.000	674.00		4
Mercury	mg/kg	0.240	9.500	7.04		4
Nickel	mg/kg	12.000	197.000	71.28		4
Potassium	mg/kg	333.000	1420.000	713.25		4
Selenium	mg/kg	1.400	17.200	8.35		4
Silver	mg/kg	24.800	24.800	24.80		1
Sodium	mg/kg	215.000	3920.000	1446.75		4
Vanadium	mg/kg	9.900	47.700	23.90		4
Zinc	mg/kg	292.000	15800.000	8720.50		4
Cyanide, Total	mg/kg	4.600	66.200	34.73		4
Percent Solids	%	57.200	93.000	78.25		4
Tent. Ident. Compound-SVOC					4	
Unknown	ug/kg	16000.000	960000.000	97038.46		26
Unknown Hydrocarbon	ug/kg	30000.000	36000.000	33000.00		2

TABLE 7-7
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Surface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Ethylmethylbenzene isomer	ug/kg	52000.000	52000.000	52000.00		1
Trimethylbenzene isomer	ug/kg	70000.000	220000.000	145000.00		2
Undecane, 4,7-dimethyl-	ug/kg	14000.000	93000.000	41333.33		6
Benzene, 1-ethyl-2-methyl-	ug/kg	39000.000	76000.000	57500.00		2
Benzene, 2-ethyl-1,4-dimethyl-	ug/kg	21000.000	60000.000	40500.00		2
Unknown Substituted Benzene	ug/kg	28000.000	84000.000	56000.00		2
Benzene, 1-ethyl-3-methyl-	ug/kg	150000.000	150000.000	150000.00		1
Benzene, 1,2,4-trimethyl-	ug/kg	16000.000	68000.000	42000.00		2
Hexadecanoic acid	ug/kg	23000.000	260000.000	141500.00		2
Decane	ug/kg	96000.000	96000.000	96000.00		1
Benzene, 1,3,5-trimethyl-	ug/kg	70000.000	92000.000	81000.00		2
Octane, 2,3,6-trimethyl-	ug/kg	320000.000	320000.000	320000.00		1
Decane, 3-methyl-	ug/kg	56000.000	56000.000	56000.00		1
Nonane, 2,5-dimethyl-	ug/kg	220000.000	220000.000	220000.00		1
Decane, 2,5,6-trimethyl-	ug/kg	48000.000	48000.000	48000.00		1
Benzene, 1,2,3,5-tetramethyl-	ug/kg	21000.000	68000.000	49333.33		3
Tetradecane	ug/kg	21000.000	21000.000	21000.00		1
Hexadecane	ug/kg	35000.000	130000.000	78000.00		3
Heptadecane, 2,6-dimethyl-	ug/kg	14000.000	150000.000	54777.78		9
Dodecanoic acid	ug/kg	190000.000	190000.000	190000.00		2
Phenol, 4-(2,2,3,3-tetramethylbutyl)-	ug/kg	19000.000	240000.000	129500.00		2
Heptadecane	ug/kg	54000.000	260000.000	157000.00		2
Dodecane, 2,6,10-trimethyl-	ug/kg	110000.000	110000.000	110000.00		1
Cycloheptane, 1,3,5-tris(met...	ug/kg	52000.000	52000.000	52000.00		1
Methyl(methylethen) benzene + Unknown	ug/kg	32000.000	32000.000	32000.00		1
1,2-Benzenedicarboxylic acid butyl-2-methyl	ug/kg	19000.000	19000.000	19000.00		1
Tent. Ident. Compound-VOC					4	
Unknown	ug/kg	5900.000	440000.000	70637.50		8
Nonane	ug/kg	39000.000	39000.000	39000.00		1
Benzene, 1-ethyl-3-methyl-	ug/kg	880000.000	880000.000	880000.00		1
Benzene, 1,2,4-trimethyl-	ug/kg	790.000	790.000	790.00		1
Benzene, propyl-	ug/kg	120.000	120.000	120.00		1
Nonane, 2,6-dimethyl-	ug/kg	4800.000	4800.000	4800.00		1
Benzene, (1-methylethyl)-	ug/kg	510.000	370000.000	133170.00		3

TABLE 7-7
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Surface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Benzene, 1,2,3-trimethyl-	ug/kg	85.000	85.000	85.00		1
Cyclohexane, methyl-	ug/kg	18000.000	18000.000	18000.00		1
Ethylmethylbenzene isomer	ug/kg	57000.000	180000.000	118500.00		2
Trimethylbenzene isomer	ug/kg	93000.000	210000.000	151500.00		2
Decane	ug/kg	24000.000	290000.000	126666.67		3
Hexane, 3-methyl-	ug/kg	55.000	55.000	55.00		1
Cyclopentane, 1-ethyl-3-methyl-, cis-	ug/kg	150.000	150.000	150.00		1
Cyclohexane, 2-propenyl-	ug/kg	73.000	73.000	73.00		1
Substituted Benzene	ug/kg	98.000	1300.000	699.00		2
3-Pentanone, 2,2,4,4-tetramethyl-	ug/kg	180.000	180.000	180.00		1
Cyclohexane, 1-ethyl-4-methyl-, trans-	ug/kg	5100.000	5100.000	5100.00		1
Trimethylbenzene + Unknown	ug/kg	16000.000	16000.000	16000.00		1

This table includes all compounds identified above detection limits in the Kapica-Pazmey Area soil samples collected at a depth of less than 3 feet(see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

TABLE 7-8
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Subsurface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Volatiles					17	
Chloroethane	ug/kg	12.000	12.000	12.00		1
Methylene Chloride	ug/kg	190.000	190.000	190.00		1
Acetone	ug/kg	79.000	8700.000	4126.33		3
Carbon Disulfide	ug/kg	3.000	3.000	3.00		1
1,1-Dichloroethane	ug/kg	5.000	790.000	378.33		3
Total 1,2-Dichloroethene	ug/kg	360.000	26000.000	9553.33		3
Chloroform	ug/kg	1.000	3.000	1.67		3
1,2-Dichloroethane	ug/kg	44.000	44.000	44.00		1
2-Butanone	ug/kg	5.000	90000.000	30012.00		3
1,1,1-Trichloroethane	ug/kg	83.000	560.000	321.50		2
1,2-Dichloropropane	ug/kg	35.000	35.000	35.00		1
Trichloroethene	ug/kg	20.000	250000.000	59444.00		5
Benzene	ug/kg	2.000	23000.000	4970.80		5
4-Methyl-2-Pentanone	ug/kg	2.000	4200.000	1423.67		3
2-Hexanone	ug/kg	4.000	390.000	197.00		2
Tetrachloroethene	ug/kg	2.000	240000.000	43466.63		8
Toluene	ug/kg	1.000	1400000.000	197543.00		13
Chlorobenzene	ug/kg	18.000	27000.000	6787.75		4
Ethylbenzene	ug/kg	2.000	570000.000	60899.93		14
Styrene	ug/kg	58.000	260000.000	87119.33		3
Total Xylenes	ug/kg	11.000	1700000.000	240252.67		15
Semi-Volatiles					4	
Phenol	ug/kg	58.000	9600.000	2974.50		4
1,2-Dichlorobenzene	ug/kg	260.000	260.000	260.00		1
2-Methylphenol	ug/kg	80.000	4100.000	1436.67		3
4-Methylphenol	ug/kg	41.000	2400.000	662.75		4
Isophorone	ug/kg	1600.000	65000.000	33300.00		2
2,4-Dimethylphenol	ug/kg	39.000	2200.000	761.00		3
Benzoic acid	ug/kg	79.000	700.000	323.00		3
Naphthalene	ug/kg	54.000	23000.000	7758.00		3
2-Methylnaphthalene	ug/kg	290.000	16000.000	8145.00		2
Dimethylphthalate	ug/kg	6500.000	6500.000	6500.00		1
Acenaphthene	ug/kg	710.000	710.000	710.00		1
4-Nitrophenol	ug/kg	66.000	66.000	66.00		1
Dibenzofuran	ug/kg	71.000	640.000	355.50		2
2,4-Dinitrotoluene	ug/kg	840.000	840.000	840.00		1
Diethylphthalate	ug/kg	1300.000	1300.000	1300.00		1
Fluorene	ug/kg	92.000	760.000	426.00		2
Pentachlorophenol	ug/kg	45.000	16000.000	8022.50		2
Phenanthrene	ug/kg	220.000	4800.000	2510.00		2
Anthracene	ug/kg	890.000	890.000	890.00		1
Di-n-butylphthalate	ug/kg	39.000	19000.000	4806.50		4
Fluoranthene	ug/kg	40.000	6000.000	3020.00		2
Pyrene	ug/kg	71.000	4200.000	2135.50		2

TABLE 7-8
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Subsurface Soils

		CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
CHEMICAL	UNITS	MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
Butylbenzylphthalate	ug/kg	20000.000	20000.000	20000.00		1
Benzo(a)anthracene	ug/kg	2100.000	2100.000	2100.00		1
Chrysene	ug/kg	1500.000	1500.000	1500.00		1
bis(2-Ethylhexyl)phthalate	ug/kg	110.000	110000.000	28477.50		4
Di-n-octylphthalate	ug/kg	890.000	3300.000	2095.00		2
Benzo(b)fluoranthene	ug/kg	2200.000	2200.000	2200.00		1
Benzo(k)fluoranthene	ug/kg	2200.000	2200.000	2200.00		1
Benzo(a)pyrene	ug/kg	610.000	610.000	610.00		1
Benzo(g,h,i)perylene	ug/kg	260.000	260.000	260.00		1
Pesticides/PCBs					16	
AROCLOR-1242	ug/kg	3200.000	34000.000	18733.33		3
AROCLOR-1248	ug/kg	9600.000	9600.000	9600.00		1
AROCLOR-1254	ug/kg	1000.000	16000.000	9275.00		4
Metals					4	
Aluminum	mg/kg	2380.000	4580.000	3372.50		4
Antimony	mg/kg	10.800	10.800	10.80		1
Arsenic	mg/kg	1.500	2.300	1.98		4
Barium	mg/kg	1490.000	1490.000	1490.00		1
Beryllium	mg/kg	0.110	0.180	0.15		4
Cadmium	mg/kg	0.090	40.400	10.19		4
Calcium	mg/kg	404.000	6650.000	3527.00		2
Chromium, Total	mg/kg	4.800	1010.000	256.95		4
Cobalt	mg/kg	12.000	12.000	12.00		1
Copper	mg/kg	478.000	478.000	478.00		1
Iron	mg/kg	1990.000	8940.000	4325.00		4
Lead	mg/kg	5.000	4060.000	1022.13		4
Magnesium	mg/kg	582.000	5170.000	2876.00		2
Manganese	mg/kg	25.500	105.000	57.63		4
Mercury	mg/kg	0.070	2.300	1.19		2
Nickel	mg/kg	12.700	12.700	12.70		1
Potassium	mg/kg	209.000	425.000	311.00		4
Selenium	mg/kg	1.500	1.500	1.50		1
Silver	mg/kg	64.300	64.300	64.30		1
Sodium	mg/kg	214.000	214.000	214.00		1
Vanadium	mg/kg	3.900	11.300	7.45		4
Zinc	mg/kg	9.400	2200.000	650.20		4
Cyanide, Total	mg/kg	21.300	21.300	21.30		1
Percent Solids	%	85.200	93.400	91.00		4
Tent. Ident. Compound-SVOC					4	
Unknown	ug/kg	180.000	210000.000	18778.80		25
Unknown Hydrocarbon	ug/kg	6800.000	69000.000	37900.00		2

TABLE 7-8
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Subsurface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Undecane, 4,7-dimethyl-	ug/kg	1800.000	58000.000	29900.00		2
Benzene, 2-ethyl-1,4-dimethyl-	ug/kg	54000.000	58000.000	56000.00		3
Unknown Substituted Benzene	ug/kg	77000.000	77000.000	77000.00		1
Benzene, 1-ethyl-3-methyl-	ug/kg	52000.000	160000.000	106000.00		2
Benzene, 1,2,4-trimethyl-	ug/kg	52000.000	230000.000	141000.00		2
Benzene, (1,1-dimethylethyl)-	ug/kg	79000.000	79000.000	79000.00		1
Hexadecanoic acid	ug/kg	10000.000	110000.000	60000.00		2
Decane, 2,5,6-trimethyl-	ug/kg	110000.000	110000.000	110000.00		1
Tetradecane	ug/kg	3400.000	3400.000	3400.00		1
Heptadecane, 2,6-dimethyl-	ug/kg	3600.000	14000.000	8366.67		3
Dodecanoic acid	ug/kg	3000.000	3000.000	3000.00		1
Phenol, 4-(2,2,3,3-tetramethylbutyl)-	ug/kg	3300.000	3300.000	3300.00		1
Tridecane, 5-propyl-	ug/kg	3900.000	3900.000	3900.00		1
Hexadecane, 2-methyl-	ug/kg	1600.000	1600.000	1600.00		1
Heptadecane	ug/kg	7900.000	14000.000	10950.00		2
Tetradecanoic acid	ug/kg	3900.000	130000.000	66950.00		2
Docosane	ug/kg	2000.000	2000.000	2000.00		1
Hexatriacontane	ug/kg	3500.000	3500.000	3500.00		1
1-Decene, 2,4-dimethyl-	ug/kg	210.000	210.000	210.00		1
Cyclohexanol, 3,3,5-trimethyl-	ug/kg	210.000	1500.000	855.00		2
Hexanoic acid, 2-ethyl-	ug/kg	470.000	470.000	470.00		1
Eicosane, 10-methyl-	ug/kg	290.000	290.000	290.00		1
Dodecane, 1-iodo-	ug/kg	210.000	210.000	210.00		1
Nonane, 2,6-dimethyl-	ug/kg	42000.000	42000.000	42000.00		1
Benzene, 1-methyl-3-propyl-	ug/kg	98000.000	98000.000	98000.00		1
Benzene, 1-ethenyl-3-ethyl-	ug/kg	44000.000	44000.000	44000.00		1
Tent. Ident. Compound-VOC					17	
Unknown	ug/kg	16.000	87000.000	8301.85		13
Nonane	ug/kg	17.000	42000.000	11907.80		5
Propylbenzene + Unknown	ug/kg	21.000	21.000	21.00		1
Benzene, 1-ethyl-2-methyl-	ug/kg	13.000	44000.000	14707.67		3
Benzene, 1,2,4-trimethyl-	ug/kg	28.000	59.000	43.50		2
Unknown Hydrocarbon	ug/kg	20.000	2700.000	890.25		4
Benzene, propyl-	ug/kg	6.500	130000.000	27422.23		6
Benzene, (1-methylethyl)-	ug/kg	9.700	7500.000	3754.85		2
Benzene, 1,2,3-trimethyl-	ug/kg	14.000	14.000	14.00		1
Cyclohexane, methyl-	ug/kg	16.000	16.000	16.00		1
Decane	ug/kg	88.000	260000.000	115017.60		5
Cyclohexane, 1-ethyl-4-methyl-, trans-	ug/kg	9.700	9.700	9.70		1
Nonane, 3-methyl-	ug/kg	29.000	29.000	29.00		1
Cyclohexane, propyl-	ug/kg	9.000	41.000	28.33		3
Heptane, 4-(1-methylethyl)-	ug/kg	19000.000	19000.000	19000.00		1
Benzene, 1,3,5-trimethyl-	ug/kg	24000.000	24000.000	24000.00		1
2-Pentanol, 4-methyl-	ug/kg	12.000	24.000	18.00		2

TABLE 7-8
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Kapica/Pazmey Subsurface Soils

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Octane, 2,3,6-trimethyl-	ug/kg	23.000	23.000	23.00		1
Octane, 6-ethyl-2-methyl-	ug/kg	37.000	37.000	37.00		1
Octane	ug/kg	3800.000	3800.000	3800.00		1
2-Hexanone, 5-methyl-	ug/kg	9.600	9.600	9.60		1
Unknown cyclic hydrocarbon	ug/kg	9.000	9.000	9.00		1
Ethylmethylbenzene	ug/kg	24.000	490000.000	73752.46		13
Trimethylbenzene	ug/kg	14.000	520000.000	76208.38		16
2-Pentanone	ug/kg	54.000	54.000	54.00		1
2-Heptanone	ug/kg	810.000	810.000	810.00		1
Hydrocarbon + unknown	ug/kg	24.000	63000.000	24274.67		3

This table includes all compounds identified above detection limits in the Kapica-Pazmey Area (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

TABLE 7-9
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Surface Water
SOURCE AREA: Drainage Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Volatiles					5	
Chloroethane	ug/l	14.000	30.000	22.00		2
Acetone	ug/l	5.000	380.000	192.50		2
1,1-Dichloroethane	ug/l	1.000	2.000	1.50		2
Total 1,2-Dichloroethene	ug/l	1.000	3.000	2.00		2
2-Butanone	ug/l	33.000	140.000	86.50		2
Benzene	ug/l	460.000	460.000	460.00		1
4-Methyl-2-Pentanone	ug/l	49.000	49.000	49.00		1
Toluene	ug/l	7.000	8.000	7.50		2
Ethylbenzene	ug/l	6.000	6.000	6.00		1
Total Xylenes	ug/l	35.000	35.000	35.00		1
Semi-Volatiles					5	
Phenol	ug/l	23.000	45.000	34.00		2
bis(2-Chloroethyl)ether	ug/l	5.000	77.000	41.00		2
2-Methylphenol	ug/l	5.000	5.000	5.00		1
bis(2-Chloroisopropyl)ether	ug/l	29.000	29.000	29.00		1
4-Methylphenol	ug/l	9.000	590.000	299.50		2
Isophorone	ug/l	5.000	5.000	5.00		1
2,4-Dimethylphenol	ug/l	12.000	12.000	12.00		1
Benzoic acid	ug/l	85.000	85.000	85.00		1
4-Chloro-3-methylphenol	ug/l	2.000	2.000	2.00		1
Pesticides/PCBs					5	
AROCLOR-1248	ug/l	0.500	0.840	0.67		2
Metals					5	
Aluminum	ug/l	470.000	960.000	730.00		3
Arsenic	ug/l	2.300	45.000	23.65		2
Barium	ug/l	330.000	330.000	330.00		1
Beryllium	ug/l	0.280	0.280	0.28		1
Cadmium	ug/l	0.370	0.720	0.55		2
Calcium	ug/l	12500.000	334000.000	113600.00		5
Chromium, Total	ug/l	5.000	28.000	12.28		4
Copper	ug/l	22.000	22.000	22.00		1
Iron	ug/l	265.000	14300.000	4967.20		5
Lead	ug/l	4.200	23.800	11.02		5
Magnesium	ug/l	1080.000	61700.000	25460.00		4
Manganese	ug/l	24.000	1850.000	771.60		5
Nickel	ug/l	55.000	80.000	67.50		2
Potassium	ug/l	650.000	30000.000	13322.50		4
Selenium	ug/l	2.100	2.100	2.10		1

TABLE 7-9
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Surface Water
SOURCE AREA: Drainage Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Sodium	ug/l	4200.000	82300.000	54500.00		3
Zinc	ug/l	53.000	88.000	64.00		4
Tent. Ident. Compound-SVOC					5	
Unknown	ug/l	10.000	620.000	127.20		25
Unknown Hydrocarbon	ug/l	16.000	16.000	16.00		1
Pentacosane	ug/l	72.000	72.000	72.00		1
Cyclohexanol, 3,3,5-trimethyl-	ug/l	420.000	420.000	420.00		1
Hexanoic acid (DOT)	ug/l	200.000	200.000	200.00		1
Phenol, 2,3-dimethyl-	ug/l	90.000	90.000	90.00		1
2-Propanol, 1-[2-(2-methoxy-1-methylethoxy)-1-2 -propanol	ug/l	36.000	36.000	36.00		1
Benzeneacetic acid	ug/l	190.000	190.000	190.00		1
Diphosphoric acid tetraethy..	ug/l	26.000	26.000	26.00		1
2,4-Pentanediol, 2-methyl-	ug/l	14.000	14.000	14.00		1
2-Propanol, 2-(2-methoxy-1-m...	ug/l	14.000	14.000	14.00		1
Benzeneacetic acid, .alpha.-ethyl-	ug/l	34.000	34.000	34.00		1
Unknown PNA	ug/l	8.000	8.000	8.00		1
Eicosane	ug/l	130.000	130.000	130.00		1
Pentanoic acid, 4-methyl-	ug/l	160.000	160.000	160.00		1
Benzeneacetonitrile	ug/l	60.000	60.000	60.00		1
2-Hexadecane, 3,7,11,15-tetr...	ug/l	42.000	42.000	42.00		1
Tent. Ident. Compound-VOC					5	
Furan, tetrahydro-	ug/l	75.000	75.000	75.00		1
3-Heptanone, 5-methyl-	ug/l	6.000	6.000	6.00		1
Ethane, 1,1'oxybis-	ug/l	14.000	14.000	14.00		1

This table includes all compounds identified above detection limits in the Surface Water Samples (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

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TABLE 7-10
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Sediment
SOURCE AREA: Drainage Area

		CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
CHEMICAL	UNITS	MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
Volatiles					18	
Chloroethane	ug/kg	40.000	40.000	40.00		1
Methylene Chloride	ug/kg	44.000	44.000	44.00		1
Total 1,2-Dichloroethene	ug/kg	6.000	6.000	6.00		1
Chloroform	ug/kg	2.000	8.000	3.17		6
2-Butanone	ug/kg	11.000	11.000	11.00		1
1,1,1-Trichloroethane	ug/kg	3.000	3.000	3.00		1
Benzene	ug/kg	23.000	14000.000	7011.50		2
Toluene	ug/kg	3.000	170.000	72.60		5
Ethylbenzene	ug/kg	130.000	130.000	130.00		1
Total Xylenes	ug/kg	200.000	200.000	200.00		1
Semi-Volatiles					18	
Phenol	ug/kg	58.000	190.000	124.00		2
bis(2-Chloroethyl)ether	ug/kg	430.000	560.000	495.00		2
bis(2-Chloroisopropyl)ether	ug/kg	1400.000	1800.000	1600.00		2
4-Methylphenol	ug/kg	100.000	270.000	185.00		2
2,4-Dimethylphenol	ug/kg	610.000	610.000	610.00		1
Benzoic acid	ug/kg	190.000	1200.000	557.14		7
Naphthalene	ug/kg	59.000	420.000	172.00		4
2-Methylnaphthalene	ug/kg	55.000	380.000	178.75		4
Dibenzofuran	ug/kg	230.000	230.000	230.00		1
Fluorene	ug/kg	75.000	75.000	75.00		1
Hexachlorobenzene	ug/kg	140.000	140.000	140.00		1
Pentachlorophenol	ug/kg	47.000	230.000	138.50		2
Phenanthrene	ug/kg	68.000	660.000	264.43		7
Anthracene	ug/kg	83.000	100.000	91.50		2
Di-n-butylphthalate	ug/kg	58.000	170.000	110.50		4
Fluoranthene	ug/kg	62.000	1000.000	423.25		8
Pyrene	ug/kg	71.000	1100.000	394.38		8
Butylbenzylphthalate	ug/kg	160.000	170.000	165.00		2
Benzo(a)anthracene	ug/kg	78.000	710.000	325.14		7
Chrysene	ug/kg	77.000	800.000	330.63		8
bis(2-Ethylhexyl)phthalate	ug/kg	51.000	13000.000	2257.36		11
Benzo(b)fluoranthene	ug/kg	56.000	1500.000	398.36		11
Benzo(k)fluoranthene	ug/kg	56.000	1500.000	408.36		11
Benzo(a)pyrene	ug/kg	63.000	690.000	327.14		7
Indeno(1,2,3-cd)pyrene	ug/kg	160.000	420.000	297.50		4
Dibenz(a,h)anthracene	ug/kg	75.000	200.000	145.00		3
Benzo(g,h,i)perylene	ug/kg	180.000	550.000	372.50		4
Pesticides/PCBs					18	
Heptachlor Epoxide	ug/kg	66.000	66.000	66.00		1
AROCLOR-1248	ug/kg	4600.000	4600.000	4600.00		1

TABLE 7-10
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Sediment
SOURCE AREA: Drainage Area

		CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
CHEMICAL	UNITS	MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
AROCLOR-1254	ug/kg	460.000	17000.000	5862.50		4
AROCLOR-1260	ug/kg	290.000	290.000	290.00		1
Metals					18	
Aluminum	mg/kg	1850.000	15700.000	6660.56		18
Antimony	mg/kg	2.800	5.100	3.95		2
Arsenic	mg/kg	1.100	22.500	6.98		18
Barium	mg/kg	63.000	107.000	78.51		8
Beryllium	mg/kg	0.080	1.000	0.46		18
Cadmium	mg/kg	0.080	4.700	1.01		16
Calcium	mg/kg	759.000	73000.000	15609.94		18
Chromium, Total	mg/kg	4.300	273.000	30.70		18
Copper	mg/kg	6.300	359.000	47.92		15
Iron	mg/kg	2550.000	34500.000	12395.56		18
Lead	mg/kg	3.600	702.000	100.01		18
Magnesium	mg/kg	443.000	22300.000	5807.31		16
Manganese	mg/kg	23.100	419.000	171.95		18
Mercury	mg/kg	0.130	8.800	2.06		5
Nickel	mg/kg	14.400	40.500	25.15		6
Potassium	mg/kg	202.000	2870.000	720.33		18
Selenium	mg/kg	0.870	1.100	1.02		3
Thallium	mg/kg	1.400	1.400	1.40		1
Vanadium	mg/kg	4.500	47.900	20.50		18
Zinc	mg/kg	6.400	271.000	106.32		18
Percent Solids	%	27.000	81.300	60.31		17
Tent. Ident. Compound-SVOC					18	
Unknown	ug/kg	140.000	17000.000	1679.27		220
Unknown Hydrocarbon	ug/kg	320.000	54000.000	3708.29		41
Hexadecanoic acid	ug/kg	1300.000	1400.000	1350.00		2
Hexatriacontane	ug/kg	1700.000	1700.000	1700.00		1
Cyclohexanol, 3,3,5-trimethyl-	ug/kg	870.000	870.000	870.00		1
Dimethylphenol	ug/kg	2200.000	2200.000	2200.00		1
1,3,5-Triazine-2,4,6(1H,3H,5)-trione, 1,3,5-tri-	ug/kg	690.000	690.000	690.00		1
Sulfur, mol. (S8)	ug/kg	180.000	5400.000	2790.00		2
Bromohexane isomer	ug/kg	790.000	5800.000	2796.67		3
PCB	ug/kg	360.000	4700.000	2253.75		8
Benzopyrene isomer	ug/kg	320.000	320.000	320.00		1
Phthalic anhydride	ug/kg	1300.000	1700.000	1500.00		2
Propanoic acid, 2-methyl-1,...	ug/kg	740.000	740.000	740.00		1
Hexane, 2,3,4-trimethyl-	ug/kg	420.000	420.000	420.00		1
Dimethyl heptadecane	ug/kg	310.000	310.000	310.00		1
Phthalate	ug/kg	2200.000	2200.000	2200.00		1
Methyltetradecane	ug/kg	1000.000	1000.000	1000.00		1
Pentadecanoic acid, 14-methyl-methylester	ug/kg	410.000	410.000	410.00		1

TABLE 7-10
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Sediment
SOURCE AREA: Drainage Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Tent. Ident. Compound-VOC					18	
Furan, tetrahydro-	ug/kg	160.000	160.000	160.00		1
3-Pentanone, 2,4-dimethyl-	ug/kg	15.000	15.000	15.00		1
3-Heptanone, 5-methyl-	ug/kg	25.000	25.000	25.00		1

This table includes all compounds identified above detection limits in the sediment samples (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

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TABLE 7-2
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Ground Water
SOURCE AREA: Upper Aquifer

		CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
CHEMICAL	UNITS	MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
Volatiles					24	
Chloromethane	ug/l	68.000	68.000	68.00		1
Vinyl Chloride	ug/l	22.000	720.000	374.00		3
Chloroethane	ug/l	3.000	2000.000	442.71		17
Methylene Chloride	ug/l	1.000	7.000	4.00		2
Acetone	ug/l	84000.000	99000.000	91500.00		2
1,1-Dichloroethane	ug/l	6.000	2400.000	981.25		4
Total 1,2-Dichloroethene	ug/l	1.000	400.000	180.67		6
2-Butanone	ug/l	150000.000	220000.000	185000.00		2
Trichloroethene	ug/l	34.000	45.000	39.50		2
Benzene	ug/l	1.000	100000.000	7265.20		15
4-Methyl-2-Pentanone	ug/l	45000.000	54000.000	49500.00		2
2-Hexanone	ug/l	1200.000	1800.000	1500.00		2
Tetrachloroethene	ug/l	160.000	200.000	180.00		2
Toluene	ug/l	21.000	2300.000	725.25		4
Chlorobenzene	ug/l	2.000	96.000	33.60		5
Ethylbenzene	ug/l	52.000	1100.000	476.00		7
Total Xylenes	ug/l	47.000	3000.000	659.57		7
Semi-Volatiles					24	
Phenol	ug/l	3.000	240.000	34.20		10
bis(2-Chloroethyl)ether	ug/l	4.000	250.000	65.67		9
1,3-Dichlorobenzene	ug/l	3.000	3.000	3.00		1
1,4-Dichlorobenzene	ug/l	3.000	10.000	5.50		4
1,2-Dichlorobenzene	ug/l	4.000	33.000	18.50		6
2-Methylphenol	ug/l	2.000	38.000	14.50		4
bis(2-Chloroisopropyl)ether	ug/l	59.000	300.000	143.20		5
4-Methylphenol	ug/l	5.000	2200.000	468.00		5
Isophorone	ug/l	19.000	35.000	26.33		3
2,4-Dimethylphenol	ug/l	6.000	110.000	41.33		3
Benzoic acid	ug/l	2.000	1900.000	323.00		6
Naphthalene	ug/l	2.000	71.000	32.50		6
4-Chloro-3-methylphenol	ug/l	2.000	2.000	2.00		1
2-Methylnaphthalene	ug/l	9.000	27.000	17.00		3
Diethylphthalate	ug/l	3.000	9.000	6.00		2
Pentachlorophenol	ug/l	2.000	3.000	2.50		2
Di-n-butylphthalate	ug/l	2.000	2.000	2.00		1
bis(2-Ethylhexyl)phthalate	ug/l	2.000	50.000	16.33		6
Pesticides/PCBs					24	
AROCLOR-1248	ug/l	2.600	2.600	2.60		1
AROCLOR-1260	ug/l	27.000	27.000	27.00		1

TABLE 7-2
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Ground Water
SOURCE AREA: Upper Aquifer

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Metals					24	
Aluminum	ug/l	250.000	280.000	265.00		2
Arsenic	ug/l	2.100	43.200	13.59		17
Barium	ug/l	230.000	1840.000	608.75		16
Beryllium	ug/l	0.250	0.250	0.25		1
Cadmium	ug/l	0.240	3.100	0.98		4
Calcium	ug/l	32100.000	1040000.000	176233.33		24
Chromium, Total	ug/l	1.100	3.900	2.43		4
Iron	ug/l	170.000	218000.000	25052.77		22
Lead	ug/l	3.200	4.600	3.90		2
Magnesium	ug/l	7270.000	78800.000	33820.56		18
Manganese	ug/l	281.000	4250.000	2099.00		23
Mercury	ug/l	1.700	1.700	1.70		1
Nickel	ug/l	48.000	53.000	49.67		3
Potassium	ug/l	1480.000	95800.000	13938.75		24
Selenium	ug/l	2.100	6.200	3.47		3
Sodium	ug/l	12700.000	444000.000	145423.81		21
Thallium	ug/l	3.100	4.000	3.55		2
Vanadium	ug/l	2.200	25.900	8.25		8
Zinc	ug/l	10.000	886.000	113.15		20
Cyanide, Total	ug/l	10.000	10.000	10.00		1
Tent. Ident. Compound-SVOC					24	
Unknown	ug/l	6.000	2600.000	249.79		86
Unknown Hydrocarbon	ug/l	36.000	1100.000	418.67		3
Ethylmethylbenzene isomer	ug/l	24.000	130.000	64.00		4
Trimethylbenzene isomer	ug/l	50.000	300.000	172.50		4
Ethyldimethylbenzene isomer	ug/l	32.000	160.000	96.00		2
Undecane, 4,7-dimethyl-	ug/l	120.000	120.000	120.00		1
Benzene, 1,1'-oxybis-	ug/l	24.000	24.000	24.00		1
Benzene, propyl-	ug/l	22.000	22.000	22.00		1
Benzene, 1-ethyl-2-methyl-	ug/l	42.000	88.000	65.00		2
Benzene, 2-ethyl-1,4-dimethyl-	ug/l	6.000	400.000	151.00		4
Unknown Substituted Benzene	ug/l	22.000	110.000	51.00		8
Unknown carboxylic acid	ug/l	22.000	22.000	22.00		1
Tetramethylbenzene isomer	ug/l	120.000	130.000	125.00		2
Benzene, 1,3,5-trimethyl-	ug/l	82.000	280.000	181.00		2
Cyclohexanol, 3,3,5-trimethyl-	ug/l	26.000	2000.000	728.57		7
Hexanoic acid, 2-ethyl-	ug/l	360.000	360.000	360.00		1
Benzene, 1-ethenyl-3-ethyl-	ug/l	18.000	18.000	18.00		1
Hexanoic acid (DOT)	ug/l	740.000	740.000	740.00		1
Dimethylphenol	ug/l	54.000	200.000	127.00		2
Cyclopentanol, 2-methyl-CI...	ug/l	52.000	52.000	52.00		1
Benzene, 1-ethyl-4-methoxy-	ug/l	90.000	90.000	90.00		1
Furan, 2,2'-methylenebis-	ug/l	150.000	150.000	150.00		1
Benzenamine, n,n-diethyl-	ug/l	32.000	32.000	32.00		1

TABLE 7-2
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Ground Water
SOURCE AREA: Upper Aquifer

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Furan, 2,2'-[oxybis(methylene)]bis,-	ug/l	32.000	54.000	42.67		3
Hexanoic acid, anhydride	ug/l	60.000	60.000	60.00		1
1,4-Methanonaphthalene, 1,4-...	ug/l	160.000	160.000	160.00		1
2-Propanol, 1-[2-(2-methoxy-1-methylethoxy)-1-2-propanol	ug/l	110.000	110.000	110.00		1
Hexanoic acid, 2-methyl-	ug/l	720.000	720.000	720.00		1
2,4-Pentanediol, 2-methyl-	ug/l	72.000	1800.000	936.00		2
2-Propanol, 2-(2-methoxy-1-m...	ug/l	90.000	90.000	90.00		1
Benzeneacetic acid, .alpha.-ethyl-	ug/l	58.000	58.000	58.00		1
Pentanoic acid, 4-methyl-	ug/l	1100.000	1100.000	1100.00		1
Disulfide, diethyl-	ug/l	140.000	720.000	430.00		2
3-Octanone	ug/l	86.000	86.000	86.00		1
Benzene, 1-chloro-3-methyl-	ug/l	120.000	120.000	120.00		1
Cyclohexanemethanol, .alpha.-.alpha.-4-trimethyl-	ug/l	220.000	220.000	220.00		1
Unknown substituted phenol	ug/l	28.000	28.000	28.00		1
Phenol, 3-ethyl-5-methyl-	ug/l	50.000	50.000	50.00		1
Benzoic acid, 3-methyl-	ug/l	38.000	38.000	38.00		1
Ethane, 1,2-bis(2-chloroethoxy)-	ug/l	50.000	78.000	64.00		2
Benzene, ethyl-	ug/l	16.000	16.000	16.00		1
Benzene, 1,3-dimethyl-	ug/l	440.000	440.000	440.00		1
Benzene, 1,2-dimethyl-4-(phenylmethyl)-	ug/l	24.000	24.000	24.00		1
Benzene, (1,1-dimethylpropyl...	ug/l	32.000	32.000	32.00		1
Naphthalene, 1,2,3,4-tetrah...	ug/l	52.000	52.000	52.00		1
1(2H)-Naphthalenone, 3,4-dih...	ug/l	12.000	12.000	12.00		1
2-Cyclohepten-1-one	ug/l	92.000	92.000	92.00		1
Benzene, 1-methyl-4-(methyls...	ug/l	14.000	14.000	14.00		1
Glycine, n-(2-methyl-1-oxo-2...	ug/l	12.000	12.000	12.00		1
Phenol, 3,5-dimethyl-	ug/l	12.000	12.000	12.00		1
1,3-Pentanediol, 2,2,4-trimethyl-	ug/l	40.000	40.000	40.00		1
2,4,6(1H,3H,5H)-Pyrimidinetrione-5-(1-methyl)-	ug/l	10.000	130.000	70.00		2
2-Methylcyclopentanol isomer	ug/l	2000.000	2000.000	2000.00		1
Trimethylphenol isomer	ug/l	62.000	62.000	62.00		1
Methylbenzoic acid isomer	ug/l	44.000	420.000	232.00		2
2-Propanol, 1-(2-methoxy-1-methylethoxy)-2-propanol	ug/l	140.000	2200.000	1170.00		2
Propanoic acid, 2-(3-chlorophenoxy)-propanoic acid	ug/l	98.000	98.000	98.00		1
Unknown substituted sulfonyl	ug/l	44.000	44.000	44.00		1
Trimethyl benzoic acid	ug/l	12.000	12.000	12.00		1
Caprolactam	ug/l	10.000	10.000	10.00		1
Octane, 2,3-dimethyl-	ug/l	320.000	720.000	520.00		2
Decane, 2,6,7-trimethyl-	ug/l	320.000	380.000	350.00		2
Nonane, 3,7-dimethyl-	ug/l	180.000	180.000	180.00		1

TABLE 7-2
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Ground Water
SOURCE AREA: Upper Aquifer

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Dimethyl undecane	ug/l	170.000	170.000	170.00		1
Methylethylphenol	ug/l	54.000	88.000	71.00		2
Unknown diol	ug/l	82.000	82.000	82.00		1
Chloromethylbenzene	ug/l	68.000	68.000	68.00		1
Disilane, hexaethyl-	ug/l	46.000	46.000	46.00		1
Unknown alcohol	ug/l	24.000	24.000	24.00		1
Methylpropenylbenzene	ug/l	6.000	6.000	6.00		1
Tetrahydronaphthalene	ug/l	66.000	66.000	66.00		1
2-Cyclohexen-1-one, 3,5,5-trimethyl-	ug/l	32.000	32.000	32.00		1
Benzoic acid, 2,4-dimethyl-	ug/l	24.000	24.000	24.00		1
Benzoic acid, 2,4,6-trimethyl-	ug/l	36.000	36.000	36.00		1
Benzoic acid, 4-(1,1-dimethylethyl)-	ug/l	34.000	34.000	34.00		1
Phenobarbital (VAN)	ug/l	8.000	22.000	15.00		2
Ethyltrimethylbenzene + unknown	ug/l	54.000	54.000	54.00		1
Methylnaphthalene	ug/l	74.000	74.000	74.00		1
Dimethylnaphthalene	ug/l	38.000	38.000	38.00		1
Tent. Ident. Compound-VOC					24	
Unknown	ug/l	29.000	140.000	73.50		8
Benzene, 1-ethyl-2-methyl-	ug/l	70.000	70.000	70.00		1
Benzene, propyl-	ug/l	60.000	60.000	60.00		1
Benzene, (1-methylethyl)-	ug/l	60.000	60.000	60.00		1
Cyclohexane, methyl-	ug/l	40.000	40.000	40.00		1
Ethylmethylbenzene isomer	ug/l	35.000	100.000	59.60		5
Trimethylbenzene isomer	ug/l	130.000	640.000	437.50		4
Benzene, 1,3,5-trimethyl-	ug/l	170.000	170.000	170.00		1
Unknown alcohol	ug/l	700.000	1100.000	900.00		2
Ethane, 1,1'oxybis-	ug/l	4.000	1500.000	264.29		7
2-Propanol, 2-methyl-	ug/l	8.000	8.000	8.00		1
Unknown oxygenated alkane	ug/l	450.000	450.000	450.00		1
Dimethylcyclohexane	ug/l	76.000	76.000	76.00		1
Ethenylcyclohexene	ug/l	63.000	63.000	63.00		1
Diethylbenzene	ug/l	78.000	78.000	78.00		1
Butanol	ug/l	40.000	40.000	40.00		1
Propane, 1,1'-oxybis-	ug/l	6.000	6.000	6.00		1
Methylpentanol	ug/l	15.000	15.000	15.00		1
Methylhexanone	ug/l	7.000	7.000	7.00		1
Cyclohexane, 1,3-dimethyl-, trans-	ug/l	45.000	45.000	45.00		1
Disopropyl ether (DOT)	ug/l	8.100	8.100	8.10		1

This table includes all compounds identified above detection limits in the Upper Aquifer Source Area (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

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TABLE 7-3
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Ground Water
SOURCE AREA: Lower Aquifer

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Volatiles					9	
Chloroethane	ug/l	3.000	440.000	214.33		3
4-Methyl-2-Pentanone	ug/l	3.000	3.000	* 3.00		1
Semi-Volatiles					9	
bis(2-Chloroethyl)ether	ug/l	11.000	12.000	11.50		2
Metals					9	
Arsenic	ug/l	2.100	8.600	4.06		5
Barium	ug/l	220.000	310.000	255.00		4
Calcium	ug/l	59000.000	151000.000	113266.67		6
Iron	ug/l	152.000	3160.000	1043.33		6
Magnesium	ug/l	19300.000	53100.000	35766.67		6
Manganese	ug/l	123.000	866.000	337.33		6
Mercury	ug/l	0.470	0.470	0.47		1
Potassium	ug/l	960.000	3420.000	1923.33		6
Sodium	ug/l	10000.000	96200.000	40700.00		6
Vanadium	ug/l	2.000	2.000	2.00		1
Zinc	ug/l	10.000	22.000	16.00		2
Tent. Ident. Compound-SVOC					9	
Unknown	ug/l	10.000	3300.000	340.59		17
Cyclohexanol, 3,3,5-trimethyl-	ug/l	2500.000	2500.000	2500.00		1
2-Propanol, 1-[2-(2-methoxy-1-methylethoxy)-1-2 -propanol	ug/l	1000.000	1000.000	1000.00		1
2,4-Pentanediol, 2-methyl-	ug/l	270.000	270.000	270.00		1
2-Propanol, 1-(2-methoxy-1-methylethoxy)-2-propanol	ug/l	530.000	530.000	530.00		1
Dimethylbenzoic acid	ug/l	400.000	400.000	400.00		1
Dimethylethylbenzoic acid	ug/l	400.000	400.000	400.00		1
Propanoic acid, 2-(3-chlorophenoxy)-propanoic acid	ug/l	170.000	170.000	170.00		1
Tent. Ident. Compound-VOC					9	
Unknown	ug/l	1200.000	1200.000	1200.00		1
Methane, dimethoxy-	ug/l	6.000	6.000	6.00		1

TABLE 7-3
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Ground Water
SOURCE AREA: Lower Aquifer

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Ethane, 1,1'oxybis-	ug/l	36.000	36.000	36.00		1
Propane, 2,2'-oxybis-	ug/l	10.000	10.000	10.00		1
Substituted methylborane	ug/l	11.000	11.000	11.00		1

This table includes all compounds identified above detection limits in the lower Aquifer Source Area (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

TABLE 7-4
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: On-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Volatiles					42	
Chloroethane	ug/kg	1.000	2.000	1.50		2
Acetone	ug/kg	88.000	7400.000	2896.00		3
1,1-Dichloroethane	ug/kg	1.000	250.000	34.00		8
Total 1,2-Dichloroethene	ug/kg	2.000	5200.000	606.63		24
Chloroform	ug/kg	1.000	6400.000	970.29		7
1,2-Dichloroethane	ug/kg	1.000	970.000	485.50		2
2-Butanone	ug/kg	4.000	210.000	101.92		12
1,1,1-Trichloroethane	ug/kg	1.000	20000000.000	884990.00		23
1,2-Dichloropropane	ug/kg	1.000	230.000	41.50		6
Trichloroethene	ug/kg	4.000	40000.000	5305.20		10
1,1,2-Trichloroethane	ug/kg	1.000	140.000	34.80		5
Benzene	ug/kg	1.000	7100000.000	205348.34		35
4-Methyl-2-Pentanone	ug/kg	2.000	650.000	119.38		13
Tetrachloroethene	ug/kg	9.000	5900000.000	430941.59		17
1,1,2,2-Tetrachloroethane	ug/kg	2.000	3900.000	779.00		7
Toluene	ug/kg	4.000	200000000.000	5292643.45		38
Chlorobenzene	ug/kg	2.000	300.000	104.14		7
Ethylbenzene	ug/kg	2.000	6700000.000	193832.14		37
Styrene	ug/kg	1.000	6200.000	3100.50		2
Total Xylenes	ug/kg	6.000	25000000.000	790871.54		37
Semi-Volatiles					14	
Phenol	ug/kg	53.000	780.000	345.33		6
1,3-Dichlorobenzene	ug/kg	110.000	350.000	230.00		2
1,4-Dichlorobenzene	ug/kg	570.000	1200.000	850.00		3
1,2-Dichlorobenzene	ug/kg	110.000	9900.000	3557.50		8
2-Methylphenol	ug/kg	42.000	9200.000	1663.50		6
4-Methylphenol	ug/kg	82.000	17000.000	3082.00		6
Isophorone	ug/kg	3900.000	88000.000	45950.00		2
2,4-Dimethylphenol	ug/kg	76.000	12000.000	2311.50		6
Benzoic acid	ug/kg	49.000	49.000	49.00		1
2,4-Dichlorophenol	ug/kg	89.000	280.000	184.50		2
Naphthalene	ug/kg	370.000	90000.000	19517.78		9
Hexachlorobutadiene	ug/kg	3700.000	3700.000	3700.00		1
2-Methylnaphthalene	ug/kg	150.000	55000.000	18580.00		6
2,4,5-Trichlorophenol	ug/kg	270.000	270.000	270.00		1
Dimethylphthalate	ug/kg	42.000	3500.000	1771.00		2
Acenaphthylene	ug/kg	340.000	5500.000	2086.67		3
Acenaphthene	ug/kg	980.000	11000.000	4493.33		3
Dibenzofuran	ug/kg	570.000	4200.000	2385.00		2
Diethylphthalate	ug/kg	46.000	47.000	46.50		2
Fluorene	ug/kg	1200.000	14000.000	5466.67		3
Pentachlorophenol	ug/kg	160.000	160.000	160.00		1
Phenanthrene	ug/kg	1500.000	20000.000	7966.67		3
Anthracene	ug/kg	94.000	94.000	94.00		1
Di-n-butylphthalate	ug/kg	160.000	36000.000	10990.00		4

TABLE 7-4
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: On-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Fluoranthene	ug/kg	54.000	3800.000	1136.00		4
Pyrene	ug/kg	250.000	5900.000	2216.67		3
Butylbenzylphthalate	ug/kg	740.000	15000.000	5713.33		3
Benzo(a)anthracene	ug/kg	170.000	170.000	170.00		1
Chrysene	ug/kg	84.000	84.000	84.00		1
bis(2-Ethylhexyl)phthalate	ug/kg	39.000	140000.000	13545.77		13
Pesticides/PCBs					31	
Endosulfan 1	ug/kg	11.000	12.000	11.50		2
4,4-DDT	ug/kg	50.000	91.000	70.50		2
AROCLOR-1242	ug/kg	130.000	400000.000	91826.00		5
AROCLOR-1248	ug/kg	600.000	990.000	795.00		2
AROCLOR-1254	ug/kg	230.000	100000.000	16871.43		7
Metals					14	
Aluminum	mg/kg	1450.000	5670.000	3187.86		14
Antimony	mg/kg	5.300	5.300	5.30		1
Arsenic	mg/kg	1.000	21.300	3.70		13
Barium	mg/kg	515.000	515.000	515.00		1
Beryllium	mg/kg	0.080	0.440	0.16		14
Cadmium	mg/kg	0.050	6.000	0.72		10
Calcium	mg/kg	183.000	38300.000	8795.71		14
Chromium, Total	mg/kg	4.600	271.000	32.15		11
Cobalt	mg/kg	22.400	22.400	22.40		1
Copper	mg/kg	6.200	115.000	22.29		8
Iron	mg/kg	1730.000	10300.000	5262.14		14
Lead	mg/kg	2.900	1440.000	112.11		14
Magnesium	mg/kg	473.000	17400.000	4368.79		14
Manganese	mg/kg	17.500	614.000	145.49		14
Mercury	mg/kg	12.400	12.400	12.40		1
Nickel	mg/kg	10.000	12.800	11.80		3
Potassium	mg/kg	264.000	764.000	483.21		14
Selenium	mg/kg	0.450	0.450	0.45		1
Vanadium	mg/kg	3.100	20.600	11.01		14
Zinc	mg/kg	9.000	747.000	71.91		14
Cyanide, Total	mg/kg	8.700	8.700	8.70		1
Percent Solids	%	65.800	89.900	84.04		14
Tent. Ident. Compound-SVOC					14	
Unknown	ug/kg	120.000	1900000.000	96398.48		33
Unknown Hydrocarbon	ug/kg	330.000	79000.000	28138.33		12
Ethylmethylbenzene isomer	ug/kg	670.000	45000.000	16323.33		3
Trimethylbenzene isomer	ug/kg	320.000	240000.000	50856.25		8
Ethyldimethylbenzene isomer	ug/kg	1300.000	36000.000	18650.00		2

TABLE 7-4
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: On-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
Undecane, 4,7-dimethyl-	ug/kg	8000.000	740000.000	379333.33		3
Benzene, 1,1'-oxybis-	ug/kg	580.000	260000.000	69263.33		6
Benzene, propyl-	ug/kg	330.000	950.000	640.00		2
Benzene, 1-ethyl-2-methyl-	ug/kg	250.000	210000.000	32077.14		7
Benzene, 1,4-diethyl-	ug/kg	28000.000	28000.000	28000.00		1
Benzene, 2-ethyl-1,4-dimethyl-	ug/kg	82.000	200000.000	24136.57		14
Unknown Substituted Benzene	ug/kg	120.000	1300000.000	251016.25		8
Benzene, 1-ethyl-3-methyl-	ug/kg	520.000	38000.000	10705.00		4
Benzene, 1,2,4-trimethyl-	ug/kg	710.000	390000.000	68680.00		6
Benzene, (1,1-dimethylethyl)-	ug/kg	370.000	370.000	370.00		1
Hexadecanoic acid	ug/kg	220000.000	220000.000	220000.00		1
Benzene, 1,3,5-trimethyl-	ug/kg	240.000	2300.000	926.67		6
Nonane, 2,6-dimethyl-	ug/kg	14000.000	470000.000	242000.00		2
Dimethylphenol	ug/kg	1100.000	1100.000	1100.00		1
Unknown fatty acid	ug/kg	9600.000	9600.000	9600.00		1
Sulfur, mol. (S8)	ug/kg	240.000	16000.000	4217.50		8
Ethyl-phenol isomer	ug/kg	1400.000	1400.000	1400.00		1
Propyl-phenol isomer	ug/kg	3400.000	3400.000	3400.00		1
Phenol, 3,5-diethyl-	ug/kg	1100.000	1100.000	1100.00		1
Methyl-methyl-ethylphenol isomer	ug/kg	870.000	870.000	870.00		1
Benzene, 1-ethyl-4-methoxy-	ug/kg	2100.000	2100.000	2100.00		1
Cyclopentene, 1-ethenyl-3-me...	ug/kg	21000.000	190000.000	100333.33		3
Dimethylbenzene isomer	ug/kg	8300.000	12000.000	10433.33		3
Unknown chlorinated biphenyl	ug/kg	240.000	4000.000	1748.75		8
Trichlorobiphenyl isomer	ug/kg	320.000	7500.000	2655.00		4
Nonane, 4,5-dimethyl-	ug/kg	240.000	870.000	555.00		2
Aroclor 1016	ug/kg	550.000	550.000	550.00		1
1,1'-Biphenyl, tetrachloro-	ug/kg	200.000	200.000	200.00		1
Benzo[B]naphtho[2,3-D]furan	ug/kg	200.000	200.000	200.00		1
Furan, 2,2'-methylenebis-	ug/kg	1400.000	1400.000	1400.00		1
Benzenamine, n,n-diethyl-	ug/kg	540.000	170000.000	35836.00		5
Ethanone, 1-(2-chlorophenyl)-	ug/kg	410.000	410.000	410.00		1
Furan, 2,2'-[oxybis(methylene)]bis,-	ug/kg	1100.000	1100.000	1100.00		1
2(1H)-Quinolinone	ug/kg	620.000	620.000	620.00		1
Benzenesulfonamide, n-butyl-	ug/kg	900.000	900.000	900.00		1
Phenol, 2-[1-(4-hydroxypheny...	ug/kg	370.000	2200.000	1285.00		2
Benzene, 1,1'-methylenebis-	ug/kg	950.000	950.000	950.00		1
Hexanoic acid, anhydride	ug/kg	2100.000	2100.000	2100.00		1
4-Carene, (1S,3S,6R)-(-)-	ug/kg	7700.000	7700.000	7700.00		1
Undecane	ug/kg	17000.000	17000.000	17000.00		1
Decane, 3,6-dimethyl-	ug/kg	8800.000	8800.000	8800.00		1
1,4-Methanonaphthalene, 1,4-...	ug/kg	10000.000	10000.000	10000.00		1
Naphthalene, 1,2-dimethyl-	ug/kg	8400.000	8400.000	8400.00		1
Benzene, (1-methylethyl)-	ug/kg	370.000	370.000	370.00		1
Benzene, 1-ethenyl-2-methyl-	ug/kg	1400.000	1400.000	1400.00		1
Benzaldehyde, 4-propyl-	ug/kg	1100.000	1100.000	1100.00		1
Naphthalene, 1-methyl-	ug/kg	240.000	240.000	240.00		1
Benzene, 1-ethyl-2,3-dimethyl-	ug/kg	160000.000	160000.000	160000.00		1

TABLE 7-4
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: On-site Containment Area

CHEMICAL	UNITS	CHEMICAL CONCENTRATION MINIMUM	MAXIMUM	ARITHMETIC MEAN	NUMBER SAMPLES ANALYZED TOTAL	DETECTED
9-Eicosyne	ug/kg	610000.000	610000.000	610000.00		1
3-Carene	ug/kg	160000.000	660000.000	410000.00		2
Tent. Ident. Compound-VOC					42	
Unknown	ug/kg	4.800	42000.000	10218.40		11
Nonane	ug/kg	5.800	70000.000	19371.87		10
Octane, 2,3-dimethyl-	ug/kg	24000.000	52000.000	38000.00		2
Propylbenzene + Unknown	ug/kg	57.000	180.000	118.50		2
Benzene, 1-ethyl-2-methyl-	ug/kg	4.800	110000.000	48204.96		5
Benzene, 1,2,4-trimethyl-	ug/kg	93000.000	93000.000	93000.00		1
Unknown Hydrocarbon	ug/kg	10.000	1400.000	484.63		8
Methylethylbenzene + Unknown	ug/kg	95.000	8300.000	4197.50		2
Benzene, propyl-	ug/kg	15.000	20000.000	8794.80		5
Benzene, (1-methylethyl)-	ug/kg	11.000	49000.000	24505.50		2
Benzene, 1,2,3-trimethyl-	ug/kg	13.000	26000.000	17503.25		4
Cyclohexane, methyl-	ug/kg	34.000	53000.000	19358.50		4
Trimethylbenzene isomer	ug/kg	1100.000	1200.000	1150.00		2
Decane	ug/kg	3300.000	320000.000	87257.14		7
Substituted Benzene	ug/kg	11.000	240000.000	24502.60		20
Trimethylbenzene + Unknown	ug/kg	12.000	12.000	12.00		1
Nonane, 3-methyl-	ug/kg	35000.000	35000.000	35000.00		1
Cyclohexane, propyl-	ug/kg	8.600	94.000	51.30		2
Cyclohexane, ethyl-	ug/kg	42.000	42.000	42.00		1
Nonane, 4-methyl-	ug/kg	180000.000	180000.000	180000.00		1
Benzene, 1,3,5-trimethyl-	ug/kg	3.600	3.600	3.60		1
2-Pentanol, 4-methyl-	ug/kg	2.300	2.300	2.30		1
Octane	ug/kg	41.000	28000.000	14020.50		2
Heptane, 2,5-dimethyl-	ug/kg	24000.000	24000.000	24000.00		1
Heptane, 2,4-dimethyl-	ug/kg	24000.000	24000.000	24000.00		1
Octane, 3-methyl-	ug/kg	27000.000	27000.000	27000.00		1
Benzene, 1-ethyl-4-methyl-	ug/kg	6.000	6.000	6.00		1
Dichlorobenzene	ug/kg	890.000	3400.000	2145.00		2
Bicyclo[3.1.0]hex-2-ene, 2-me...	ug/kg	55000.000	370000.000	212500.00		2
Hexane, 2,4-dimethyl-	ug/kg	25000.000	25000.000	25000.00		1
Unknown cyclic hydrocarbon	ug/kg	27.000	27.000	27.00		1
Ethylmethylbenzene	ug/kg	8.600	3400.000	447.90		14
Trimethylbenzene	ug/kg	4.900	83000.000	9696.70		17
Unknown ketone	ug/kg	12.000	94.000	53.00		2
Decane + unknown	ug/kg	34.000	38000.000	12695.33		3
Ethylmethylheptane	ug/kg	1600.000	1600.000	1600.00		1
Ethylmethyloctane	ug/kg	1900.000	1900.000	1900.00		1
Methyl(methylethyl) benzene	ug/kg	1400.000	1400.000	1400.00		1
Dimethylundecane	ug/kg	1800.000	1800.000	1800.00		1
Cyclohexane	ug/kg	290.000	290.000	290.00		1
Tetramethylbenzene	ug/kg	11.000	11.000	11.00		1
Unknown bicyclic hydrocarbon	ug/kg	24.000	24.000	24.00		1

TABLE 7-4
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: On-site Containment Area

		CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
CHEMICAL	UNITS	MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
Hydrocarbon + unknown	ug/kg	89.000	160.000	124.50		2
Unknown substituted cyclonex	ug/kg	62.000	62.000	62.00		1
Dichloropentane	ug/kg	1100.000	1100.000	1100.00		1
Dichloromethylbutane	ug/kg	2200.000	2200.000	2200.00		1
Dimethyloctane	ug/kg	18000.000	18000.000	18000.00		1
Dimethyldecane	ug/kg	8900.000	8900.000	8900.00		1

This table includes all compounds identified above detection limits in the On-Site Containment Area (see table 7-1 for samples included in this area), and is provided as the starting point in the development of a Set of Chemical Data for use in the Risk Assessment, as discussed in Section 7.1.2.1. Refer to appropriate appendices to determine the total parameters analyzed and their associated detection limits. Refer to appendix U for values used in risk calulations. The data values presented contain a maximum of three significant digits for the results of metals analyses and two significant digits for organic chemical analyses: additional digits are due to limitations in the computer program used to prepare these tables, and do not infer an increase in accuracy. The number of tentatively identified compounds designated as unknowns may exceed the total number of samples analyzed because more than one unknown compound may be present in a given sample.

TABLE 7-5
ORGANIC AND INORGANIC CHEMICAL CONCENTRATIONS
AMERICAN CHEMICAL SERVICES RI/FS
GRIFFITH, INDIANA

MATRIX: Soil
SOURCE AREA: Still Bottoms/Treatment Lagoon

		CHEMICAL CONCENTRATION			NUMBER SAMPLES ANALYZED	
CHEMICAL	UNITS	MINIMUM	MAXIMUM	ARITHMETIC MEAN	TOTAL	DETECTED
Volatiles					28	
Methylene Chloride	ug/kg	12000.000	260000.000	136000.00		2
Acetone	ug/kg	8100.000	12000.000	10050.00		2
1,1-Dichloroethane	ug/kg	12.000	22000.000	5095.33		6
Total 1,2-Dichloroethene	ug/kg	2.000	120000.000	21870.67		12
Chloroform	ug/kg	2.000	2100000.000	286342.21		19
1,2-Dichloroethane	ug/kg	120.000	40000.000	15780.00		4
2-Butanone	ug/kg	15.000	350000.000	59485.77		13
1,1,1-Trichloroethane	ug/kg	6.000	21000000.000	1093134.14		21
Carbon Tetrachloride	ug/kg	530000.000	3600000.000	2065000.00		2
1,2-Dichloropropane	ug/kg	17.000	22000.000	7363.40		5
Trichloroethene	ug/kg	6.000	1700000.000	183544.80		20
1,1,2-Trichloroethane	ug/kg	2.000	8100.000	2710.33		3
Benzene	ug/kg	9.000	170000.000	38794.00		17
4-Methyl-2-Pentanone	ug/kg	65.000	1500000.000	234670.28		18
Tetrachloroethene	ug/kg	23.000	1600000.000	266225.88		26
Toluene	ug/kg	14.000	23000000.000	1704183.48		27
Chlorobenzene	ug/kg	2.000	2.000	2.00		1
Ethylbenzene	ug/kg	2.000	8400000.000	751032.21		28
Styrene	ug/kg	18000.000	90000.000	54000.00		2
Total Xylenes	ug/kg	41.000	9400000.000	1978405.75		28
Semi-Volatiles					28	
Phenol	ug/kg	110.000	170000.000	20293.18		22
bis(2-Chloroethyl)ether	ug/kg	99.000	110000.000	13728.18		17
2-Chlorophenol	ug/kg	130.000	130.000	130.00		1
1,3-Dichlorobenzene	ug/kg	180.000	880.000	543.33		3
1,4-Dichlorobenzene	ug/kg	98.000	5200.000	2032.57		7
Benzyl alcohol	ug/kg	180.000	1600.000	1060.00		3
1,2-Dichlorobenzene	ug/kg	45.000	53000.000	9170.83		18
2-Methylphenol	ug/kg	120.000	15000.000	1875.56		9
4-Methylphenol	ug/kg	46.000	43000.000	4099.71		17
Isophorone	ug/kg	41.000	2600000.000	313641.24		21
2,4-Dimethylphenol	ug/kg	80.000	2600.000	580.00		10
Benzoic acid	ug/kg	130.000	50000.000	10785.00		8
2,4-Dichlorophenol	ug/kg	41.000	4100.000	1480.33		3
1,2,4-Trichlorobenzene	ug/kg	110.000	4300.000	1882.00		5
Naphthalene	ug/kg	260.000	750000.000	97080.74		27
Hexachlorobutadiene	ug/kg	55.000	40000.000	7678.93		14
4-Chloro-3-methylphenol	ug/kg	420.000	420.000	420.00		1
2-Methylnaphthalene	ug/kg	91.000	320000.000	57668.56		27
2,4,6-Trichlorophenol	ug/kg	750.000	750.000	750.00		1
2,4,5-Trichlorophenol	ug/kg	96.000	96.000	96.00		1
2-Chloronaphthalene	ug/kg	1800.000	1800.000	1800.00		1
Dimethylphthalate	ug/kg	65.000	320000.000	62443.24		17
Acenaphthylene	ug/kg	40.000	3900.000	1970.00		2